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MARCH, 1853.

CIVIL ENGINEERING.

Railway Accidents; their Cause, and Means of Prevention. By Captain Mark Huish, Assoc. Inst. C. E. Edited by Charles Manby, M. Inst. C. E., Secretary.*

Continued from page 103.

Allusion has now been made to those points connected with the road, and the machinery employed upon it, from which loss of life and injury to person and property most generally arise. The whole of these causes, however, do not produce a tithe of the accidents which result from inattention to signals, and the neglect of regulations. Of all sources of danger on a railway, these are the most prolific. Human agency is necessarily imperfect, and it cannot be expected that the servants of a railway Company, however carefully selected and diligently tutored, will be exempt from such a general law. The effects of a momentary forgetfulness, or an instant's neglect, are frequently fraught with tremendous consequences, and the miscalculation of a few yards may produce the most lamentable results. There is, therefore, no part of the system to which the railway manager looks with more anxiety, than to the efficiency of the signals on the line. If these are either defective, or too limited in number, the casualty which will probably result, must be attributed to the carelessness which has overlooked the danger, or to the injudicious economy which has permitted it. Railway stationary signals have within a few years been greatly improved. The introduction of the lofty semaphore has left little to be

* Proc. Inst. Civ. Eng., April 27th, 1852.—London Railway Journal, No. 700.

desired in this respect, while the further use of the auxiliary signal has completed this most necessary adjunct to safe working. The distance at which these signals should be planted, must depend on the nature of the ground, and the character of the gradient. Generally speaking, with the prevailing high speeds and heavy trains, the extended arm of an auxiliary signal should be seen at a distance of from 800 to 1500 yards. The space within which a train can be pulled up varies very much, according to the state of the weather, as well as to the tenacity of the brakes, the speed, the inclination of the road, and the weight of the load; but for practical purposes, the distance named above will be found to answer, and less than this should not be accepted, where circumstances permit its being obtained. Not only is the positive safety of the train secured by such a signal, but the nerve and the steadiness of the engine driver is supported by the feeling that the means of protection are provided for him. Care should be taken to fix the signal, so that no distant object may interfere with the free sight of it, and as the speed, weight, and number of trains on the line increase, opportunity should be taken periodically to revise the distances, to ascertain that every doubtful point is covered, and that nothing which may be provided against by caution, is left to contingency. Some difference has existed among railway managers, as to the mode of dealing with signals, at junctions with branch lines. It has, however, been gradually ruled, that the safest course is to keep the danger, or stop signal, fixed against the branch, so that no train may be allowed to enter on the main line until such signal be removed. The safety of the trains moving between stations, and temporarily impeded, from any cause, depends on the attention paid by the guards to the regulation, to proceed back a certain distance with the hand signal. This distance varies from 500 to 800 yards, according to the rules of different Companies. Probably the latter is too far, unless the distance terminates in a curve, as a hand signal may be seen under ordinary circumstaces, from 300 to 500 yards further. Nothing is more difficult, however, than to secure strict obedience to this rule, and the most particular attention should attach to any breach of it. Upon it hinges the safety of the train, and the fact of no accident happening, should not be a bar to the most severe punishment of the offending party. A careful guard will also be guided by the state of the rails and the atmosphere: if the former are what is termed "greasy," or the latter is heavy, a longer distance than ordinary is evidently required to protect the train. Until recently no special means exist of securing a train against collision during a fog. The detonating signal supplied this deficiency, and has become one of the most useful protections which the railway manager possesses. Its use, therefore, is universal, as in a humid climate like that of England, it was absolutely necessary to complete the code of signals. During a recent dense fog which lasted two days, and was so thick as to render objects invisible at a distance of a few yards, the London and North Western Railway was necessarily worked entirely by the detonating signals. The experiment was successful, and although irregularities were very frequent, no accident occurred, although nearly 400 trains ran during that anxious time.

Great weigh is generally attached to the question of regularity in the

times of the trains, as an essential element in their safety, and whenever an accident occurs the press and public opinion, as expressed through a jury, seize on this point as the primary cause of the mishap. The author would by no means undervalue the importance of punctuality, and as rigid an adherence as possible to the published time-tables, but it may be doubted whether undue stress has not been attached to it. Under a well regulated system of signals, and with a well disciplined staff, the greatest irregularity, whatever inconvenience it may produce, ought not to lead to danger. To a certain extent the very uncertainty of the passage of trains produces safety, by the continual vigilance it necessitates, and as few accidents occur in the most busy thoroughfare of London, so the most crowded parts of a railway exhibit the greatest freedom from casualty.

It is fortunate, indeed, that the public safety is not necessarily linked with punctuality, for the extension of the system, and the connexion with cross lines, by coaches and steamboats, is daily importing into the long trains fresh chances of delay. The mail train of the London and North Western Company starts from Dublin on the west, and Aberdeen on the north; during its passage it connects with a great number of railways, the irregularities of each and all of which become multiplied as the train advances. When, therefore, it reaches the London and North Western line, it has probably missed its appointed turn; it consequently becomes an exceptional train during its entire transit, yet none is better protected, or passes along the line with greater safety. The facility of working a trunk railway, with a heavy traffic, under the variations alluded to, has, however, been greatly promoted by the introduction and extensive use of the electric telegraph. Just as the demands on the railway system were beginning to outgrow its existing machinery for safety, this remarkable power came to its aid, and extended its capacity in an incalculable degree. The effect cannot be better illustrated than by a reference to its operation on the London and North Western Railway during the great Exhibition. Prior to the opening the Directors had been much pressed by the Royal Commissioners, for greatly reduced fares, to afford all classes of the community an opportunity of participating in an enjoyment which could not be expected to recur. The result is well known. The most distant parts of the kingdom poured their population into London, and the aggregate number exceeded expectation. In addition to the passengers by the ordinary trains on the railway, which were very largely increased, 775,000 persons were conveyed to and from London by the excursion trains, for whose conveyance 24,000 extra carriages passed through the Euston Station. The receipts of the railway rose to £70,000 in a single week. That such an extraordinary traffic centering in a single focus, arriving at irregular hours, and in almost unlimited numbers from more than thirty railways, should have been carried on for six continuous months without the most trifling casualty, or without interruption to the very extensive business in merchandise, coals, and cattle, continually moving on the line, and with a remarkable punctuality (looking to the contingencies arising from the irregularities of neighboring lines), is due, not more to the discipline and good conduct of all the servants, than to the power of regulation which a liberal use of the telegraph placed at their disposal.

The author, who had the charge of the whole arrangements, foresaw the impossibility of reliance being placed on ordinary measures to govern so irregular a traffic. From the very great distance many of these trains had to traverse before reaching the North Western Railway, dependent in many cases, also, on steamboats, and the delay incident on overloaded trains, it was impossible to rely on any time bill framed by the forwarding Company, while the number of these excursion trains, flowing from every quarter, and amounting sometimes to between twenty and thirty a day (many of them not known to be *en route* till they reached some one or other of the termini of the line), rendered it impossible to fix any specific time for their transit. The attempt would have so clogged and impeded the service as to have introduced the greatest irregularity into every department. Under these circumstances the following plan was adopted, and continued with success throughout the whole period of the Exhibition. The running speed of all excursion trains was fixed with reference to their weight, and a general rule in accordance was issued. Instant notice was given by telegraph of the arrival at and the departure of each train from every terminus, and this information being re-transmitted to every important station, and repeated as the train passed in both directions, a time bill was immediately constructed, according to the prescribed table of speeds, from which correct information was obtained and acted on with promptness and precision, and thus, instead of dependence being placed on theoretical time bills, which in the majority of cases would have created difficulty and confusion, the telegraph, by tracing every train through its entire journey, became a practical instrument of safety of infinitely greater value. On every long line of railway the first class stations are rarely more than twenty miles apart. It is evident, therefore, that by the establishment of telegraphic instruments at these distances, the railway becomes a system of detached and corrective links, and the irregularities inseparable from the system are modified and adjusted. Some years ago a strong impression prevailed in high quarters, that the trunk line of the London and North Western Railway was overloaded with traffic, and relief lines were talked of as a consequent necessity. By the improvements since introduced, and by the assistance which science has thus placed at the disposal of that Company, the traffic has been double in quantity, and there is at this moment a greater capacity for increasing it further, than at any previous period of its history. The value of the telegraph, for the working of tunnels, and the absolute protection from collision which is thus afforded, cannot be overrated.

The length to which these remarks have extended, renders it necessary to be very brief in alluding to other and less important causes of accident.

Defective brakes and fractures of couplings on steep inclines, have not unfrequently led to accident, yet the working of the Lickey incline is evidence of the safety of the system, if only ordinary care and caution are exercised. More than one accident has arisen from trees falling across the rails. Care should, therefore, be taken to remove all that are likely to be affected by storms, or by the slipping of the ground. Trains have occasionally been thrown off the rails by cattle jumping out in transit, and some very narrow escapes have occurred in consequence. Level

crossings are also a fruitful source of danger if they are not very carefully watched. A sad catalogue of deaths at these crossings will be found in the parliamentary returns, and their increasing number indicates the necessity for greater vigilance, or a change of practice. Lastly, reference must be made to the tendency of Parliament, in recent sessions, to extend what are termed "running powers." It is to be greatly feared, that if this system is permitted to extend, a new element of the greatest danger will be introduced, the effect of which it is at present scarcely possible to calculate. If, with the whole energies of a concentrated establishment, under well known rules and discipline, danger cannot be avoided, what must be expected from strange and rival executives using the same line of rails, and unacquainted with its peculiarities?

The regulations of most Companies have now a very general similarity of principle, modified by the circumstances of each line. These rules are constantly undergoing improvement, and any fresh cause of danger is provided for, as it develops itself. Accidents, however, very rarely happen from foreseen circumstances. They are generally of a compound character, and result from the simultaneous conjunction of several causes. It is easy to be wise after the event, but so long as machinery is material, and human nature is fallible, it is to be feared, that although experience and skill may diminish, they will not prevent the recurrence of events that startle society, and cast blame on railway management. The rapid glance which has been thrown on the more salient points of danger, show the variety of causes from which it may at any moment arise. The increasing nature of the transit renders such casualties possible at any moment. In the year 1851, during which 7,900,000 passengers (nearly one-third of the population of England) traveled on the London and North Western Railway, only one individual met his death—yet this casualty, from which the author also suffered, was the effect of the gravest disobedience of orders. The exception proves the rule, and it is due to the engine drivers and guards of Great Britain, to state, that there is probably no class of men, to whom such serious duties are intrusted, and who repay with such fidelity, attention, and skill, the confidence reposed in them. Kind and considerate treatment, and good wages, combined with the utmost strictness of discipline,—a readiness to reward merit, and a rigid determination to punish severely any dereliction of duty, are the best means of forming good and attentive servants. Inebriety should never, under any circumstances, be overlooked, or pardoned, whatever claims the offender may otherwise possess in regard to general efficiency, or length of service. A system of regular promotion, wherever it can be applied, is perhaps the greatest stimulus to good conduct; and experience has clearly shown, that, in general, better results have been obtained by rewarding obedience, than by the greatest severity in punishing misconduct. The habits of order and regularity which are thus generated, extend beyond their immediate sphere, and react on society at large. As an instrument for advancing the social position of the country, the railway system, with all its admitted defects, exercises no light influence, and although the benefits are not unmixed with evil, the advantages are purchased at a less cost of personal suffering and sacrifice, than (looking at the conditions under which they are obtained) might reasonably be expected.

Report of Edward Miller, Esq., Ch. Eng., upon the Western Connexions and Extensions of the Pennsylvania Railroad.

J. Edgar Thomson, Esq., Pres. Penn. Railroad Co.

Sir:—In accordance with the instructions of the Board of Directors, I have endeavored to procure the most accurate information concerning the different extensions of the Pennsylvania Railroad westward; and have verified it by personal examination of the maps, profiles, and estimates of the respective companies, where I was able to do so. I cannot, however, pretend to have done this universally, nor to have passed over the numerous lines of railroads in Ohio, having a bearing on this subject. The Board are fully aware that to have done so with a view of examining these lines professionally, would have required more time than it has been possible to spare from my pressing and immediate duties upon the Pennsylvania Railroad.

Boston, New York, Philadelphia, and Baltimore, are now striving to obtain the trade of the West; and all these cities have constructed railroads for the purpose. New York alone possesses two of these avenues, one by the Hudson River and Albany and Buffalo Railroads, and the other the New York and Erie. The Albany and Buffalo line, together with the Western and Worcester roads of Massachusetts, form the Boston route. Philadelphia has constructed her road to Pittsburg, and Baltimore her own to Wheeling. The latter city is also engaged in the construction of the Parkersburg branch, of which the present road to Wheeling will form the main stem as far as Three Forks. The topographical features of the country appear to forbid the construction of any great leading line within the limits of the United States, independent of these, and within their range, with one exception, the Sunbury and Erie Railroad.

It is not unusual to speak of the West as if it were practicable to divert its entire trade to a single city by a single railroad. It is, however, a great commercial reservoir, which even now is able to fill all the channels constructed to carry off its surplus, and which will require all of them soon to be increased in capacity and stretched to their utmost limits, to carry away its treasures as rapidly as they accumulate. The enterprise of our western neighbors, the aid they have received from eastern capital, and the facilities of construction, are rapidly covering Ohio, Indiana, Illinois, Kentucky, and Southern Michigan, with a net-work of railroads, which appear on the map at first view as a confused mass of competing and interfering lines. Some of these will prove failures, and others projected as leading lines will sink into the position of branches and feeders to those better placed and supported. But it is certain that the keen competition produced by their number, and the remarkable facilities afforded by them, will stimulate agricultural productions to the utmost; and that those lines which become either by intrinsic merit or adaptation, the leading thoroughfares, will be very profitable. A close investigation of the map will show that various causes have concentrated upon certain points several railroads, which appear to radiate from these places in dif-

ferent directions. The principal of these are Pittsburg, Wheeling, Cleveland, Cincinnati, St. Louis, Chicago, Columbus, and Indianapolis. Of these, nature and art have combined to make Pittsburg, Cleveland, Cincinnati, Chicago, and St. Louis, great centres of trade; and divergent lines are now in progress, or completed, which will connect Philadelphia by direct routes with all these places, and also with Lexington, the central point of Eastern Kentucky. Western Kentucky will be best reached through Cincinnati.

It is not my intention to enter into a discussion of the relative merits of the different seaboard cities, or of their lines of communication with the interior, being satisfied that all these cities will reap the rich harvest of their laudable enterprise, and that all these avenues will find full and profitable employment. In a commercial point of view, however, there can be no doubt that the interests of Philadelphia require her to be connected by ties of sympathy with those railroads which will afford the best and most direct communication with the important points just named; and that she should not be wholly dependent for any portion of her trade upon such routes as pass through rival cities, or are subjected to their caprice, influence, and interference.

Taking the leading routes which may be considered as dependent mainly upon Philadelphia, and commencing at the north, we have the Ohio and Pennsylvania Railroad, now upon the point of completion, which commences at Pittsburg, the western terminus of the Pennsylvania Railroad, and passing through the great wheat belt of Ohio, by way of the important towns of Salem, Canton, Massillon, Wooster, and Mansfield, terminating at Crestline on the Cleveland and Columbus Railroad. It is crossed by lines running west of north to Cleveland and Sandusky, which are completed, and is extended by the Ohio and Indiana road to Fort Wayne, on the direct route to Chicago; and by the Bellefontaine and Indiana roads to Indianapolis and Terre Haute, on the way to St. Louis.

On the south it is now connected by the way of Columbus with Cincinnati, and will soon have a more direct communication with that city by the Mount Vernon road to Springfield.

These lines, the construction of which is now rendered secure by the aid and countenance of the Pennsylvania Railroad Company to the Ohio and Pennsylvania, Ohio and Indiana, and Mount Vernon roads, will give access to a country of immense production, by routes sufficiently favorable to afford a vast advantage to the Pennsylvania Railroad even for that trade which seeks New York as its market.

Of the propriety of granting this aid, and of the beneficial results which must follow it, I do not entertain a doubt; the full advantage, however, will not be realized, until by a branch line and bridge over the Allegheny river the two roads are brought side by side, and the present charges for drayage abolished, which operate as a tax in favor of New York and Baltimore. The gauge of these lines is four feet ten inches.

The next line to be considered commences also at Pittsburg, and passes through Steubenville and Coshocton to Newark, where it connects with the Central Ohio road to Columbus. It is intended hereafter to extend it by an independent line to that point, where it will join the Co-

lumbus, Piqua, and Indiana road. All these roads have the Pennsylvania gauge of four feet eight and a half inches, and will connect us with the Indiana roads of the same gauge, which will thus be unbroken from Philadelphia to St. Louis, on a very direct and feasible route.

The Pittsburg and Steubenville Company have not yet succeeded in obtaining the right of constructing their road through the narrow neck of Virginia, but hope to do so this winter. After obtaining this, should they need aid, they will possess strong claims upon Philadelphia for assistance. The gradients upon this line correspond with those of the Western Division of the Pennsylvania Railroad.

The next line which requires attention is the Hempfield Railroad, commencing at Greensburg, thirty-one miles east of Pittsburg, and extending through Washington to Wheeling. From this point two roads diverge; the central Ohio road through Zanesville and Newark to Columbus; and the Marietta and Cincinnati road through Marietta and Chilicothe to Cincinnati. The first is completed from Zanesville to Columbus.

The Central Ohio road, at Zanesville, intersects the Wilmington road, passing through Lancaster, Circleville, Washington, and Wilmington, to the Little Miami road, by which it is connected with Cincinnati. This is the shortest line from Philadelphia to Cincinnati, but its gradients are less favorable than those of the Ohio and Pennsylvania, Steubenville, and Marietta lines. Its projectors have hitherto looked towards Baltimore for assistance and sympathy, but it will be an important feeder to Philadelphia. The Central Ohio and Wilmington roads have the four feet ten inch gauge.

The Marietta and Cincinnati road is the most southern extension of the Pennsylvania road now in progress. The Company asks for aid from Philadelphia, and looks to the Pennsylvania Railroad Company for efficient assistance and countenance. It is of special importance to us, as being the only route by which the trade of Southern Ohio and Eastern Kentucky can reach Philadelphia, except through Baltimore. The gauge is undetermined, but will be made to correspond with that of Pennsylvania, if Philadelphia aid be obtained; otherwise the weakness of the Company may force a union with the Hillsborough road, on which the gauge of four feet ten inches has been laid down. In this case the Wheeling connexion will be necessarily abandoned. This Company possesses the only single charter covering the entire ground from Wheeling to Cincinnati. Knowing the interest felt in this road by many of the most intelligent merchants of Philadelphia, on account of their business relations with Southern Ohio, Kentucky, and Tennessee, and feeling very doubtful myself about the propriety of affording the amount of aid which would be required from Philadelphia to secure the early completion of the Hempfield and Marietta Railroads, I considered it necessary to look more fully into this case than either of the others, and have become satisfied that the commercial interests of Philadelphia require their prompt construction. I certainly did not expect to arrive at this conclusion when I entered into the examination you required.

The Marietta road is in progress of construction from Marietta to the vicinity of Blanchester. About seventy-seven miles will be completed

next fall—the funds and iron for the same being now procured; the determination of the gauge should therefore be made at once. The Company is constructing their road in a permanent manner, and the masonry of the bridges and culverts is of superior quality. The maximum gradient is fifty feet per mile, the minimum radius of curvature two thousand eight hundred and sixty-five feet. The Sciota and Hocking road on the south connects it with Portsmouth, from which point the Maysville and Big Sandy road, now advertised for contract, extends to Maysville. From Maysville, railroads are in progress through Lexington to Danville, which will soon be connected with Nashville and Knoxville.

The line passes through Chilicothe, the former capital of Ohio, and the county seat of Ross, of which the agricultural productions are said to be greater than any county in Ohio, and probably in the United States. To this point the Virginia Central Railroad is aiming, and in a late report of the Chief Engineer of that road upon their proposed extension through Gallipolis to Chilicothe, he speaks of intersecting the Marietta road at that point, "as the key to the whole interior commerce and traveling of the State."

I can see no mode by which Southern Ohio, Eastern Kentucky, and Tennessee, can be made tributary to Philadelphia, except through the Hempfield and Marietta Railroads; and the aid and countenance of Philadelphia appear to be essential to their prompt construction.

The amount which the respective companies ask is $500,000 for the Hempfield, and $750,000 for the Marietta road. With the funds already secured, and the prestige arising from the approval and adoption by Philadelphia of these roads as a part of her grand plan, I believe that these subscriptions will be sufficient to insure the completion of both these roads—the aggregate cost of which will be over eight millions of dollars.

Statement of distances from Philadelphia to Cincinnati by different routes:

No. 1, via Pittsburg, Crestline, and Columbus,	717	miles.
2, via Pittsburg, Loudenville, Mount Vernon, and Springfield,	697	"
3, via Pittsburg, Steubenville, Coshocton, Newark, and Columbus,	662	"
4, via Greensburg, Wheeling, Zanesville, Newark, and Columbus,	657	"
5, via Wheeling, Zanesville, Wilmington, and Circleville,	646	"
6, via Wheeling, Marietta, Athens, Chilicothe,	651	"

From the above tabular statement, it will be seen that the length of the Marietta line to Cincinnati is less than any of the others, except No. 5, by Wheeling, Zanesville, and Wilmington, which is only five miles shorter; it is six miles less than Central Ohio; eleven miles less than Steubenville and Indiana; forty-six miles less than Mount Vernon and Springfield; and sixty-six miles less than Ohio and Pennsylvania. Pointing in a different direction and diverging widely from the Ohio and Pennsylvania road, it is not even a competitor for the great legitimate business of that company. For the trade of Cincinnati, it will necessarily be a rival to the other lines, and for this purpose is not essential to Philadelphia; but, as has already been shown, none of the others can give us access to Southern Ohio, Kentucky, and Tennessee—and a good connexion with these is indispensable.

Three railroads appear to be necessary to secure the ends pointed out

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in the commencement of this report, and, in my judgment, these are: the Ohio and Pennsylvania, with the Fort Wayne extension to Chicago, and connexions with Sandusky and Cleveland; the Pittsburg and Steubenville to Columbus, Indianapolis, and St. Louis; and the Marietta to Cincinnati and Kentucky. With these Philadelphia will have nothing to fear from any quarter. The Cleveland and Pittsburg Railroad Company are about to commence an important extension of their line from Wellsville, the present terminus on the Ohio river, to Wheeling and Rochester; thus forming with the Ohio and Pennsylvania road, and the Marietta and Cincinnati road, a continuous line on the northwestern bank of the Ohio from Pittsburg to Marietta, 160 miles. This may well be called a Grand Junction Railway, as it will connect all the lines I have described with the Pennsylvania Railroad and the Baltimore and Ohio Railroad, uniting no less than nine important railroads at their termini. The gradients and curvatures are extremely favorable, and in case of accident to any of the bridges or ferries proposed, it will be inestimable. I consider it a very important road, both for Philadelphia and Pittsburg.

I have said nothing on the subject of railroad bridges across the Ohio river at Wheeling and Steubenville. The question is of too much magnitude to be summarily disposed of, and in this communication I can only deal in generalities. At Wheeling, five railroads will meet, two on the East bank and three on the West bank. I think there can be no reasonable doubt that the magnitude of the interests involved will produce a harmonious arrangement, by which all these will be accommodated; and I hope the same will be the case with Steubenville.

Referring to the reports and exhibits of the different corporations for more minute details than can be embraced in a general report of this character, I have the honor to subscribe myself,

With great respect,

EDWARD MILLER,

Chief Engineer, Pennsylvania Railroad.

Philadelphia, Jan. 27, 1853.

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*Hodge's Self-Lubricating Axle Box.**

This important invention was thus described, in a paper read before the last general meeting of the Institution of Mechanical Engineers, held at Birmingham, at which Mr. Robert Stephenson, M. P., the President, presided:

No part of the machinery of the railway requires constant lubrication more than the axle journals of locomotives, tenders, and carriages, as the heating of one journal in the whole train is sufficient to produce the most serious results, not only in delay to the traffic, but endangering the lives of the passengers in the train.

Notwithstanding the great attention this point has received, scarcely a train that passes over our roads (in the summer more particularly), but some one or more of the axle journals heat. In one instance the writer experienced, the whole train had to be passed into a siding for more than two

* From the London Mechanics' Magazine, December, 1852.

hours before it could again proceed on its journey. He was induced, through what he had experienced of the difficulties attendant on the use of grease as a lubricator, and from what he knew of the use of oil in the United States, to write to the inventor of the best lubricating box in that country, knowing that the difference of cost of lubricating was more than one-half in favor of oil, with a proper box. He obtained a patent in this country for the inventor, and on application to Mr. J. E. McConnell, of the London and North Western Railway, a trial of the axle box was at once made on some of their carriages.

On no railway in the United States is grease used as a lubricator; many patents have been taken out in that country for axle boxes, but the plan now brought before the meeting seems to be preferred, and is universally adopted. The average distance that carriages run there before any additional oil is supplied to the boxes, or before the journals and brasses are examined, is 8000 miles. This fact has been fully corroborated by the working of these boxes on the London and North Western Railway. The first boxes were put on the tender of No. 182 engine, which was immediately put on to the most trying work, during hot weather—sometimes running express trains at the highest speeds, and at other times at the worst possible work—ballasting; and yet, after running 6000 miles in four months, without any additional oil, the journals and brasses were in as perfect a condition as when new.

The axle box consists of an upper chamber, which is filled full of cotton waste, flax, sponge, or any other capillary material, to retain and pass the oil up to the journal. There is also a lower or secondary chamber, for the reception of the dirty oil, which finds its way down the space at the back of the bridge wall, with a tap screw at the bottom to let it out. A covering plate is bolted on to the front of the box, which is its only opening besides the hole for supplying oil, closed by a screw. Upon the axle a wrought iron collar is shrunk, having a groove turned in it to receive a leather flanch.

The results of the trial of the new axle boxes in the tender No. 182, upon the London and North Western Railway, have been officially reported as follows, to Mr. McConnell, by his assistants:—"The axle boxes have up to 20th Sept. last, run 5743 miles; the bearings have been examined, and are found in a very satisfactory state. No oil has been supplied since the first day of running, four months previously: 10 quarts of oil have been supplied to the boxes altogether, and 5 quarts have been drawn off during the time from the bottom chamber, which is still good oil for screwing, drilling, and other ordinary work; the oil remaining in the boxes is considered sufficient, without more being added, to run at least from 3000 to 4000 miles more. The journals and brasses are wearing beautifully, with faces as though polished in the latter; and a great advantage is found, that the great wear endways does not take place on the brasses, as in the ordinary boxes using yellow grease or tallow. The cost of lubrication is greatly reduced, as appears from the following account of the comparative consumption of the above tender with the new axle boxes, and another tender exactly similar, except that it was fitted with old boxes on Normanville's plan, using tallow, both tenders having run

the same distance, 6000 miles, under the same circumstances of trains, and the weather being dry and dusty nearly the whole of the time:

New Axle Boxes.

Oil put into the boxes at starting, 10 quarts at 9d.,	7s.	6d.
Credit by 5 quarts drawn off from the bottom chamber, at 6d.,	2	6
Actual cost of oil,	5	0
Cotton waste, 4 lbs., at 2d.,	0	8
Leathers, 4½, at 1s.,	4	6
	10	2

Actual cost per day, 1·54d., or 1½ d. per day.

Old Axle Boxes.

Tallow required per day, 2 lbs. at 4½d., or.	9d per day.
Saving per day on the six new boxes,	7½d per day.

Weight of the six old axle boxes,	3 cwt.	1 qr.	0 lbs.
Weight of the six new axle boxes,	1	2	20
Saving in weight of the six new boxes,	1	2	8

The advantages of this axle box over those now in use are—

Firstly. The perfect exclusion of dirt or grit from the box, by means of the leather and wrought iron collar.

Secondly. The certainty of constant and never failing lubrication to the journals and brasses by means of the capillary medium placed in a separate chamber, and detached from the back of the box by means of the bridge wall, so that the hydraulic lead of the oil can be carried much higher than the joint of the leather and collar, allowing the upper chamber to be full of oil if necessary, while it is impossible that any oil can leak out at the back.

Thirdly. The provision of a secondary or under chamber for the dirty oil to drop into, from which it is drawn off, refined, and again returned to the upper chamber, or is issued in the machine shop for drilling, cutting bolts, and many other purposes, and is equally good as new oil.

Mr. McConnell said he believed the statement in the paper was correct about the results of the trial he had made of the axle box. There was a perfect exclusion of dirt from the journal, and the keeping it constantly in contact with the oil was an important advantage. He was satisfied they must, ere long, abandon grease for oil; there was a great loss of power from defective lubrication of the carriage and wagon journals in cold weather, as there were no lubrication in action on first starting, until the journals got heated, and then they were liable to get too hot, and the grease ran away, and was scraped off the outside of the boxes, and put in again mixed with grit at the stations. Oil was generally ready for action in any weather, and he thought Railway Companies must ultimately adopt oil for all moving journals, particularly with the present increase in the speed of trains, and the weight on the working bearings.

Mr. Lea, of London, mentioned a new material for lubrication that he was bringing into application; it had been tried some years since by Mr.

Ramsbottom, with very satisfactory results; but further trials had been suspended till now, from difficulties of the inventor, who was now dead. This lubricating substance consisted of a peculiar semi-fluid composition, applicable to the present axle boxes; oil was the basis of the composition, but thickened with india rubber and other materials; it had an affinity for the iron bearing, which prevented the displacement of the material from the rubbing surface. The manufacture of the material was not expensive, costing only 4*d.* per lb.; and when charged at 16*d.* per lb. it had been found in the trial made that there was a very considerable saving in the cost of lubrication compared with the ordinary grease or tallow. He wished to make a further trial of it on railways, and thought it would prove an important improvement. There was a great advantage in this plan, from requiring no change in the present axle boxes. No ordinary pressure in the bearings could squeeze out the lubricating material; therefore it remained between the surfaces, preventing contact, and consequently preventing any heating by friction.

Mr. H. Wright said he had known several kinds of oil boxes, but they were all liable to the spilling of the oil from side blows and oscillations. The employment of the cotton waste in the axle box, described in the paper, he thought was decidedly a good plan to prevent the oil from spilling over, and he inquired the result that had been found in the trial on the London and North Western Railway?

Mr. McConnell replied, that there appeared to be no spilling or loss of oil, and the dust and grit were effectually kept out of the box. The oil drawn off from the bottom chamber was very black and thick, and not suitable to use again in that state, though it might be fit for drilling purposes, &c.; but after being properly purified it was very good for lubrication again. There was a bridge at the back of the axle box, just high enough to prevent the oil from flowing off; the oil did not come into contact with the leather joint, which was only to prevent the entrance of grit and dust.

Mr. Chillingworth remarked that there was a plan of lubrication with a cork ball, about 1 inch diameter; two of these balls floated on the surface of the oil, rolling against the journal to distribute the oil. He believed it was a French invention, but did not know the result of its application.

Mr. McConnell said he was not acquainted with that plan. The leather in the new axle boxes was not found to wear away, and appeared likely to last a long time, as there was no pressure or strain upon it; the leather was not bent, but simply fitted easily into the groove in the iron collar, which was shrunk on to the axle.

Mr. H. Wright observed, that the leather would probably wear the iron away before it was worn away itself.

Mr. Allan remarked, that he had used sponge in the axle boxes of engines for the last ten years, and found the results very satisfactory. They found that the consumption of oil, which was previously six to eight quarts for the 100 miles trip between Birmingham and Liverpool, was now reduced to one quart, partly by the introduction of sponge in the axle boxes of the ten bearings of the engine and tender. The plan still

continued very successful, and they had adopted it generally in their engines and tenders.

Mr. Forsyth (of Wolverton) remarked, that one circumstance had not been mentioned, in the description of the new axle boxes tried on the London and North Western; the cotton was rammed in tolerably tight from the front, filling the boxes up solid except against the ends of the axles. The cotton was put in dry, and it became gradually saturated, by pouring in oil from time to time at the top hole; it would continue to absorb oil for several days. The surface of the cotton waste, when examined after running the 6000 miles, was like a metallic polished surface next the journal, but still it was found saturated with oil close up to the surface of contact. The leathers were cut straight up three-quarters of an inch from the axle, but not bevelled, to get them into the groove of the iron collar, but no leakage was found to take place, as the cotton was not over saturated, and the oil never came in contact with the leather so high up as the cut.

On the Drainage of Towns. By Mr. R. Rawlinson.*

It was contended that town sewers could not receive the excessive flood waters, even of the urban portion of the site; that they should never receive the suburban drainage, nor be combined with water courses; that they should be adapted solely to remove the solid and liquid refuse from the houses; and that it was safer for the inhabitants that there should be no sewers at all, rather than they should be of such dimensions as to become places of deposit. Pumping could be profitably adopted in certain situations, where from the level, or the effect of tidal influence, the outlet flow might be checked. Intercepting sewers at mid-level were approved. Sewers of minimum dimensions were advocated in connexion with pumping, and they should be capable of resisting internal hydraulic pressure in case of the water rising in them. The flow through sewers should be constant, and it was argued this could only be secured by having small conduits. With regard to earthenware pipes, three inches diameter was considered too small for any drain pipes, and thirty inches diameter too large for the material of which they were made. Pipes of four inches diameter would probably be found the least sectional area that should be used for house drains, and nine inches for streets, and then not at a less gradient than one in sixty. It was decided that the beneficial use of pipe sewers could not be pushed beyond certain limits; but the system should not be entirely condemned because it had been carried to extremes by those who wanted experience. The general success of the use of egg-shaped pipe sewers at Manchester was given as an example of the advantageous adoption of the pipe system. The various kinds of joints were described, and it was recommended not to use pipes of larger diameter than about fifteen inches, as larger sizes were apt to be fractured from unequal bearing at the joints. The difficulty of moulding, drying, and burning pipes increased probably as the squares of the diameters; if large pipes were moulded too thin, they were liable

* From the London Athenæum for November, 1852.

to be crushed in the sewer; and if they were moulded of extra strength, the wet pipes collapsed with their own weight in drying, were twisted out of shape in burning, or were imperfectly vitrified. Sewers of radiated bricks, moulded for the purpose, were better and cheaper than earthen pipes; a sewer thus constructed, three feet in diameter, being cheaper than one of pottery pipe of twenty inches diameter, their relative capacities being as the squares of their diameters; and there was no reason why brick sewers should not be as smooth within, and as impervious, as any pottery pipe. The discussion of the paper was commenced, but adjourned until November 30, when it was announced that the whole evening would be devoted to it.—*Proc. Inst. of Civ. Eng. Nov.* 23.

AMERICAN PATENTS.

List of American Patents which issued from Jan. 11th, to Feb. 8th, 1853, *(inclusive,) with Exemplifications by* CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

JANUARY 11TH.

17. For an *Improvement in Rakes to Harvesters;* Thomas Baylis and Daniel Williams, Tecumseh, Michigan.

Claim.—"What we claim as our invention and improvement is, the construction and method of operating the rake, together with the use of the jointed brake in facilitating the discharge of the sheaf at the rear of the machine, as set forth."

18. For an *Improvement in Lathes for Turning Interior and Exterior Surfaces;* Nathan Chapin, City of New York.

Claim.—"Having described the devices by which turning of profile work is effected, what I claim as my invention is, constructing the clamping heads with a V projection on the interior face, in combination with the orifices, to act through said clamps and V projection, for the purpose of introducing key slats, in order to retain the pieces firmly in position, during the operation of turning the interior and exterior surfaces.

"2d, I claim giving to the sliding and vibrating interior cutter, suspended on the stationary mandrel, motion corresponding to the pattern to be turned, by a rod passing through the stationary mandrel, in the manner and for the purpose herein described."

19. For an *Improvement in Porous Cells for Galvanic Batteries;* Moses G. Farmer, Salem, Massachusetts.

Claim.—"I claim as my invention the improved cell, as made substantially as described, viz. with a part only of it porous, or so as to permit the electricity to pass from the nitric acid or liquid within it, through such part and into the liquid surrounding the cell, the remainder of the cell being made by glazing or other means impervious to the passage of electricity and acid or liquid through it, as specified."

20. For an *Improvement in Scythe Fastenings;* Pinckney Frost, Springfield, Vermont.

Claim.—"What I claim as my invention is, the peculiar construction of the loop and the set ring, with the grooves, in the manner and for the purpose set forth."

21. For an *Improvement in Mode of Operating Circular Saws;* Ammi M. George, Nashua, New Hampshire.

"The nature of my invention consists in supporting and guiding a circular saw, which is driven by friction applied near its periphery, by means of a guard plate, upon which is placed an arbor, fitting a circular opening in the centre of the saw plate, and around which the saw runs, by which means I am enabled to saw boards or veneers of a width almost equal to the diameter of the saw."

Claim.—"Having described my invention, what I claim therein as new is, in combination with a circular saw driven by friction near its periphery, the guard plate with its arbor, around which the saw runs, and by which it is held into the wood, and on which

the board or veneer being sawed may rest, and relieve the saw from all friction therefrom, and by which means I am enabled to cut boards or veneers of nearly equal width with the diameter of the saw, substantially as described."

22. For an *Improvement in Fire Polishing Glass;* John L. Gilliland, Brooklyn, N. Y.

Claim.—"What I claim as my invention is, the method, substantially as described, of fire polishing glass by means of a rotating table, provided with a hollow handle, or its equivalent, and gear, by which said table can be rotated, as described."

23. For an *Improvement in Buckles;* Peter P. R. Hayden, City of New York

"The nature of my invention consists in a peculiar manner of uniting or connecting the two ends of the body of the buckle together, viz. by means of a boss formed at each of the ends of the body, said bosses being in contact with each other, and forming a bulb, around which one end of the tongue is clasped; the end of the tongue which surrounds the bulb having a recess or groove in it, in order to prevent the tongue from slipping off of the bulb."

Claim.—"What I claim as new is, constructing the buckle in the manner substantially as herein shown and described, viz. by uniting or connecting the two ends of the body of the buckle by means of a boss formed at each of the two ends of the body; said bosses being in contact with each other, and forming a bulb, around which one end of the tongue is clasped; the end of the tongue which surrounds the bulb having a recess or groove in its inner surface, which conforms to the convexity of the bulb, and keeps or binds the bosses firmly together, and also keeps the tongue in its proper place."

24. For an *Improvement in Manure Spreaders;* Silas A. Hedges, Lancaster, Ohio.

"My improvements consist in constructing a cart with two bodies, the front one of which is capable of being raised so as to discharge the manure into the rear one, by means of throwing a shaft, which is connected with the front end of it, by a tackle, into gear with the hind axle; and in providing an inclined endless apron in the rear body, which is also actuated by the hind axle, and so arranged with the tail board, that by means of a lever it is thrown into gear simultaneously with the raising of the tail board."

Claim.—"Having fully described my invention, what I claim therein as new is, constructing a manure cart with two bodies, the front one of which is raised or tilted for the discharge of manure into the rear one, by the action of the hind axle, by means of the axle and tackle, when thrown into gear by the hand lever, arranged and operating in the manner and for the purpose set forth.

"I also particularly claim the combination of the endless apron, the tilting body, and raising the tail board simultaneously with throwing in gear the endless slotted apron, in the manner and for the purposes fully set forth."

25. For an *Improvement in Manufacturing Copying Paper;* William Mann, Philadelphia, Pennsylvania; ante-dated July 11, 1852.

Claim.—"What I claim as my invention is, the copying paper herein described, composed of Manilla fibre or the equivalent thereof, tempered with cotton or its equivalent, substantially as herein set forth."

26. For an *Improvement in Screw Cutting Dies;* Andrew Mayer, Philadelphia, Penn.

Claim.—"What I claim as my invention is, arranging solid dies between the side plates, or their equivalents, of a stock, in such a manner that they are free to play, to a limited distance, in a plane perpendicular to the axis of the bolt or pipe to be screwed, while they are at the same time incapable of revolution in the same plane, substantially in the manner and for the purposes described."

27. For an *Improved Method of Connecting the Sheets of Sheet Flue and Water Space Steam Boilers;* Richard Montgomery, City of New York.

Claim.—"Having described my improvements in steam boilers, what I claim as new is, riveting together the overlapping flanches of the opposite sides of the sheet flues in steam boilers in the manner described, whereby the flues are firmly attached each to each, and the usual flue sheet is dispensed with; and also certain advantages in construction attained in other parts of the boiler, as described.

"I also claim the method of connecting a series of flues and water spaces with the roof or arch of the fire box, by means of tongues, which project from the latter and are secured alternately to the faces of the water spaces and to the tops of the flues."

28. For an *Improvement in Smut Machines;* Dan Pease, Jr., Floyd, New York.

Claim.—"What I claim as my invention is, the employment of the adjustable deflector,

set at an angle to throw the grain in different directions, in combination with the receiver, the top of the said receiver being adjustable to any height desired, and the front piece of the same being set in such a position, in relation to the deflector, that it will, when the grain strikes the deflector, be thrown against the said plane surface, which from its peculiar position will throw the grain in a partially spread state up against the adjustable top, which causes it to spread still more, and then to fall down on the ribbed bottom, and pass off through the wind pipe.

"I also claim causing the grain to spread to a greater or less degree, by making the top of the receiver adjustable to different heights, in the manner and for the purpose herein described."

JANUARY 18TH.

29. For an *Improvement in Operating the Treadles of Looms;* Robert W. Andrews, Stafford, Connecticut.

"The nature of my invention consists in operating each treadle by means of a mover, having two outwardly acting cam surfaces of unequal lengths combined in one piece, in such a manner that the portion of the said mover upon its arbor can be reversed for the purpose of doubling its capacity for producing different movements and retentions of the treadles, substantially as hereinafter set forth."

Claim.—"What I claim as my invention is, operating each treadle by means of a mover, having two outwardly acting cam surfaces of unequal lengths combined in one piece, and producing the movements and retentions, substantially as herein set forth. I also claim such a form and arrangement, respectively, of the treadles and the movers, that the treadles can be reversed in their positions upon their fulcrums, and thereby cause a reversal of the movement and retentions of the said treadles, substantially as herein set forth."

30. For an *Improvement in Bedstead Fastenings;* Charles L. Bauder, Cleveland, Ohio.

Claim.—"What I claim as my invention is, the fastening of bedsteads by the use of a metal bar, having upon its extremities, arms with inner faces formed of sections of screws; which arms work against the faces of castings, secured in the bed posts, and to the ends of the rails, thus drawing the ends of the rails against the posts; the faces of these castings against which the arms of the bar work, being likewise constructed of sections of screws, the joint being kept close, and the bedstead firm, by the pressure of the slat frame, caused by the weight of the bed and its occupants, upon arms attached to the metal bar; thus forming a self-tightening fastening, the whole being constructed and arranged as herein fully set forth."

31. For an *Improvement in Machinery for Reducing Metal Bars;* Dexter H. Chamberlain, Assignor to Cyrus G. Howard, Boston, Massachusetts.

Claim.—"What I claim as my improvement is, the combination of the bolster with the three rollers, as arranged and made to operate together, substantially in manner and for the purpose as specified; the object of the said bolster being to prevent the over-riding, or squeezing out of the metal, so as to form a fin between the rollers, as stated."

32. For an *Improvement in Saddle-Trees;* Joseph Contner, Milroy, Pennsylvania.

Claim.—"Having described the nature of my improvement, what I claim as my invention is, connecting the bridge spring seat to the pommel of the saddle, by hooking or fastening the hook or curvature, on the front end of the longitudinal centre spring of the bridge spring seat, to the semi-oval or semi-circular steel or iron plate or strap, fastened down underneath the pommel, by screws or otherwise, through its legs to the legs of the pommel, to give additional spring or play by its motion on its pivots to the seat, and to allow the bridge spring seat to be disconnected from the frame of the saddle when necessary, and to strengthen the pommel by rendering the hole through it near the horn (which weakens it) for connecting with the seat unnecessary."

33. For an *Improvement in Driving Circular Saws, &c.;* George and David Cook, New Haven, Connecticut.

Claim.—"What we claim is, the curved or hooked tooth pinion, acting in the manner and for the purposes herein before set forth."

34. For an *Improvement in Harness Boards for Jacquard Looms;* Edward Everett, Lawrence, Mass., and Samuel T. Thomas, Lowell, Massachusetts.

"Our invention is designed to facilitate the operation of changing the relative position

of the mail cords or heddles, in a jacquard loom, when the number of threads in a given breadth of the cloth is to be increased or diminished; our improvement being confined to that part of the loom commonly called the 'hole board.' "

Claim.—"What we claim is, the sectional harness board, in combination with the movable supporting bars, placed on each side of the frame for the purpose of adjusting and retaining said harness boards in the position required; the whole constructed, combined, and arranged, in the manner and for the purpose specified."

35. For an *Improvement in Wool Condensers;* James S. Hogeland, Lafayette, Indiana.

Claim.—"Having described my improved wool condenser, what I claim as new therein is, the method herein described, of detaching the ropeings from the rub roller, and guiding them on their passage to the spool, in such manner as to prevent them from being unequally deflected, and thereby unequally stretched, by means of a relief and guide roller, arranged and operating substantially as herein set forth."

36. For an *Improvement in Screw Cutting Dies;* John Griffiths, Philadelphia, Pa.

Claim.—"What I claim as my invention is, the circular die with an offset, which makes a cutting edge, which is held in position by a bolt and screw nut, the threads which are cut in its periphery being parallel, instead of having a running pitch, substantially in the manner and for the purposes as herein before described."

37. For an *Improvement in Compounds for Stereotype Plates;* John L. Kingsley, City of New York.

Claim.—"Having stated clearly the nature, and described the process of preparing my gum compound, specially adapted to the stereotype plates and moulds, I wish it to be distinctly understood, that I do not claim the mixture of the gums, gutta percha, india rubber, etc., with other non-elastic gums, resins, etc., or shellac, sulphur, etc.; nor do I claim vulcanizing; nor do I use vulcanized compounds; nor do I claim mixing the elastic gums with the alkaline earths, or earth proper; nor with the carbonates; nor the sulphates of these bases, as pulverized marble, plaster of paris, epsom salts, etc.; all of these things having been done before by Nelson Goodyear and others, for hardening and otherwise modifying the elastic gums; but what I do claim as my invention is, the making of stereotype moulds and plates of the raw or uncured gum, combined with the pulverized oxide of iron and antimony, or their equivalents, in manner and for the purpose herein set forth."

38. For an *Improvement in Corn Shellers;* Jeremiah P. Smith, Hummelstown, Penn'a.

Claim.—"What I claim as new are, the beveled spring blocks, or shelling bars, in separate pieces, in the manner and for the purpose set forth in the preamble and specification; but I do not claim to be the inventor of spring blocks or shelling bars."

39. For an *Improvement in Valves of Rotary Steam Engines;* Joseph W. Webb, Assignor to Benjamin Gould, Aurora, New York.

Claim.—"Having fully described my invention, what I claim is, making two exhaust openings, such as described, separate and distinct from each other, through each steam and cut-off valve; said valves having seats on the upper as well as lower side of the steam chamber, each of said exhaust openings communicating with the exhaust chamber, through apertures in the upper side of the steam chamber, which are opened and closed at pleasure, by slides used in connexion with the valves for governing or reversing the engine."

40. For an *Improvement in Seed Planters;* Samuel and William Witherow, Assignors to Samuel Witherow, Gettysburgh, Pennsylvania.

Claim.—"Having fully described the nature of our invention, what we claim therein as new is, the arranging of the spring slide and roller, within a box or tube forming one end of the hopper, in such manner as to prevent any more seed from leaving the hopper than is required for planting; the whole being arranged in the manner and for the purpose specially set forth. We also claim the arrangement of the drag bar under the plough beam, and passing through the adjustable hanger, and a slot in the neck of the mould board, for the purpose of giving additional lateral support to it, and protecting it from the earth which runs up in the mould board in turning the furrows; the whole being arranged and combined in the manner and for the purpose herein set forth and described."

JANUARY 25TH.

41. For *Improvements in Method of Joining Corners of Boxes, &c.;* John Bell, Harlem, New York.

"The nature of my invention consists in so forming a joint at the corners of boxes,

drawers, or similar articles, as to prevent their coming apart when the lid or bottom is fastened on, thereby being secured in a manner superior to dovetailing or other modes heretofore known."

Claim.—"What I claim as my invention is, the joining of corners of boxes, &c., by means of double oblique parallel mortises and tenons, so that neither the sides nor ends can be separated or displaced without previous removal of the top and bottom of the box, as set forth substantially in the foregoing specification and accompanying drawings."

42. For *Improvements in Working the Condenser attached to Steam Diaphragm Pumps;* James Black and Orson Beecher, Philadelphia, Pennsylvania.

Claim.—"What we claim as our invention is, 1st, The pipe and valves, or their equivalents, so constructed and arranged as to draw the air, &c., from the condenser, and drive it into the discharge pipe, or elsewhere, by the column of water in said pipe, operated by the working of the diaphragm, which causes said column of water to work the equivalent of an air pump to the condenser.

"2d, The pipe and valve, or their equivalents, so constructed and arranged as to draw the water from the condenser by the raising of the diaphragm, thus causing the water pump to work an exhaust pump, or its equivalent, to the condenser, at the same time that it does its ordinary work, substantially as described."

43. For an *Improvement in Manufacturing Wigs;* Chas. Bourgard, City of N. York.

Claim.—"Having fully described my invention, I do not confine myself to the precise means of giving motion to or adjusting the several parts essential to the operation of the machine; I know that it is possible to move and adjust them in other ways, to produce the same effect; and I do not claim the employment of the hooked or bearded needle, irrespective of the manner of its employment. But I claim (for the purpose of making the partings, or those parts of wigs and all articles of a similar nature where the artificial scalp or skin is visible, and the surrounding parts,) the employment of two or more adjustable slide frames, for carrying the silk or other material into which the hair is to be inserted, and the hair to be inserted therein, in combination, substantially as described, with a reciprocating hooked or barbed needle, either the said frame or needle having such a movement as is necessary to insert the hairs at a proper distance apart."

44. For an *Improvement in Tanning Hides and Skins;* Henry Bretney, Springfield, O.

Claim.—"Having described my improved process of tanning hides, what I claim as new therein is, continuously towing the hides in separated layers through the tanning liquor, in such manner that each hide, made fast only at one edge or end to the towing mechanism, will be greatly stretched and kept spread out by the resistance of the liquor, which is caused freely to circulate in contact with both sides or surfaces of the hides, whereby every hide, of quantity however large, is equally and constantly exposed to the action of the tanning liquor, and the stretching action upon the hides adjusted, substantially as specified."

45. For an *Improved Feed Motion in Sewing Machines;* Freeman Palmer, Conneaut, O.

Claim.—"What I claim as my invention is, the arrangement and combination of parts, by which the material to be sewed is carried under the needle in a way to secure any required length of stitch, consisting of the shaft and the screw regulator, together with the lever and clamp upon the feed wheel, substantially as herein described."

46. For an *Improvement in the Manufacture of Seamless Felt Wearing Apparel, &c.;* Samuel M. Perkins, Springfield, Pennsylvania.

Claim.—"Having described my invention, what I claim is, the art or method, as described, of making seamless felt articles of use and wearing apparel, by giving the batting of wool or fur the desired shape, and uniting its edges where required with silk or any other non-shrinking equivalent, or by such shrinking threads or fibre as will resume their original state when dry, substantially as herein before set forth.

"I do not claim the mode of carding or preparing the batting, as that is well known long before my invention; nor do I claim the shrinking or felting process, as that has also been well known."

47. For an *Improvement in Machines for Paring Apples;* William H. Lazell, City of New York, Assignor to Henry F. Willson, City of New York, and S. E. Fenwick, Washington, D. C.

Claim.—"What I claim is, the apple paring machine, constructed with a stationary circular rack or way, in combination with a traversing lever for operating the fork, on

which the apple or other article is placed, the said handle having a pinion on it, which traverses the said rack and gives rotary motion to the fork, making the apple to revolve against the swinging spring knife, while the handle is pushed backwards and forwards in a horizontal direction by the operator, in the manner substantially as described, for the purpose set forth."

48. For an *Improvement in the Frames of Piano Fortes;* Jos. Piffaut, N. Orleans, La.

"The nature of my invention consists in so constructing the metallic frames of piano fortes as that the inside frame, or that which supports the long bridge of the piano, may be raised or lowered at pleasure, and thus raise or lower the tone of the instrument, and at the same time keep up the general accord of the piano."

Claim.—"Having fully described my invention, what I claim therein as new is, in combination with the metallic frame of a piano forte, the movable part which supports the bridge, and which is raised or lowered at pleasure by means of a key operating through the screws and levers, or their equivalents, for the purpose of raising or lowering the tone of the instrument, and at the same time preserving its accord, substantially as described."

49. For an *Improvement in Sugar Draining Machines;* Joseph W. Archibald, Porto Rico, West Indies, Assignor to Horace Southmayd, City of New York.

Claim.—"Having described the nature and operation of my invention, what I claim as new is, the employment of fibrous or flexible bag, made of cotton, linen, hair cloth, or any other substance, placed loosely or secured by loops, as described, in a centrifugal depurating sugar machine, inside of the wire gauze cylinder, and containing the sugar; said bag not being permanently attached to the machine, by any screw or clamp, &c., but to be freely placed in, and then lifted out of the machine entirely, when the sugar is depurated, for the purposes set forth."

50. For an *Improved Gold Washer and Amalgamator;* Abiather F. Potter, Boston, Mass.

Claim.—"What I claim as my invention is, 1st, A wheel, or its equivalent, arranged in the tube above mentioned, so as to be operated by the water containing the metals, &c., as it issues into or descends in the tube, so as to agitate the water, by the motion of the wheel, whether it is made to operate some other agitating apparatus or otherwise.

"2d, I also claim the openings, *f f*, or their equivalents, in combination with the openings, *t t*, or their equivalents, substantially as described, for giving such direction to the water as will move the mercury, in the manner and for the purposes set forth, substantially as described."

51. For an *Improvement in Expanding Drills;* Thomas Prosser, City of New York.

Claim.—"Having described several means of applying my invention, I do not profess to conform myself to any of them, as to the mere mode of operating the screw, and thereby causing the cutter to advance or expand simultaneously with the operation of cutting or drilling. What I claim is, the combination of the inclined cutter, with a screw cut thereon, bevel screw pinion, or its equivalent, and collar, arranged in the manner described, so that by holding said collar during the rotation of the drill, a continuous feed motion is communicated to the cutter."

52. For an *Improvement in Omnibus Registers;* Peter Taltavull, Washington, D. C.

Claim.—"Having fully described my improved omnibus register, what I claim therein as new is, the spring, operated and arranged in combination with the inclined planes and escapement tube, in the manner and for the purpose substantially as herein described."

53. For an *Improvement in Winnowers of Grain;* Augustus B. Childs, Rochester, New York; patented in England, May 22, 1852.

Claim.—"I claim the regulating of the blast for the second winnowing of grain, by combining with the revolving fan which generates both the first and second blast, and compensating safety valve, as herein set forth; but I make no claim to a spring valve in itself, as such a contrivance is well known for various purposes.

"I also claim the self-regulating valve, which prevents the admission of air into the machine while it opens to discharge the impurities separated from the grain, and thus prevents an undue accumulation of them at the bottom of the air chamber."

Re-issues for January, 1853.

1. For an *Improvement in Reaping Machines;* Wm. F. Ketchum, Buffalo, New York; patented July 10th, 1847; re-issued 11th January, 1853.

Claim.—"What I claim is, the crooked arm or coupling piece, separate or in combination with the cutter bar, whether both be composed of one, two, or more pieces. I also

claim attaching, supporting, and sustaining said cutter bar to the frame, relatively to the driving wheel, substantially as herein described and represented, and for the purpose set forth. I also claim the endless chain, sickled edged cutter, in combination with the pulleys and rack teeth, arranged and operating substantially as in the manner and for the purpose set forth."

DESIGNS FOR JANUARY, 1853.

1. For a *Design for a Cooking Stove;* Sherman S. Jewett and Francis H. Root, Buffalo, New York, January 25.

Claim.—"What we claim as new is, the device "prairie flower," on the front plate; the arrangement and configuration of the floral device ornamenting the side door, consisting of a full blown central flower, stems, foliage, and pendant flowers, and the ornamental configuration of the smaller door, as herein represented and described."

2. For a *Design for a Wood Stove;* Sherman S. Jewett and Francis H. Root, Buffalo, New York, January 25.

Claim.—"What we claim as new therein is, the configuration and arrangement of the ornamental device on the side plates of the stove, as represented and described. We also claim the ornamental design of the fire door, as represented and described. We likewise claim the ornamental configuration of the bottom plate, as described."

3. For a *Design for a Cooking Stove;* Sherman S. Jewett and Francis H. Root, Buffalo, New York, January 25.

Claim.—"What we claim as new therein is, the configuration and arrangement of the ornamental design of the plate, as shown and described."

4. For a *Design for a Cooking Stove;* Joseph G. Lamb, Cincinnati, Ohio, Assignor to Alexander Bradley, Pittsburg, Pennsylvania, January 25.

Claim.—"What I claim as new is, the arrangement and combination of the ornaments, mouldings, panelings, and shapes, into the above specified design for cooking stove, substantially as above shown."

5. For a *Design for a Cooking Stove;* Joseph Pratt, Assignor to Bowers, Pratt & Co., Boston, Massachusetts, January 25.

Claim.—"I claim the ornamental configuration or design, substantially as represented in the drawings, and as above described."

FEBRUARY 1ST.

1. For an *Improvement in Machinery for Cutting Barrel Heads;* Chas. B. Hutchinson, Waterloo, New York.

"My invention consists in the use of clamp rings to hold the wood for the head, and present it to be cut and dressed by rotating cutters; said cutters being arranged upon a rotating disk and arms, in a peculiar combination to be hereafter described in detail, in such a manner, that the head may be cut out, face dressed, and beveled or chamfered on the edge, by a single operation."

Claim.—"In relation to the head turning apparatus, I am aware that there is nothing novel in the use of clamp rings as such, or of rotating cutting tools, such as flem knives, chamfering chisels, and face planers, set on disks or otherwise; but the peculiar combination and arrangement of all these, which I have adopted, I believe to be wholly novel and not heretofore used either for the purpose herein specified, or any other. What, therefore, I claim as new is, the use of clamp rings to hold the pieces of heading, and hung in bearings on opposite sides, or in any equivalent way, so as to be reversible, in combination with the adjustable rotating cutters to cut and bevel the edge of the head, and with the face cutters arranged upon the disk substantially as described, whereby the opposite sides of the head may be successively presented to the action of the cutting tools, and the head cut out, chamfered, and face dressed, or cut out and chamfered only, at one operation."

2. For an *Improvement in Frames for Lanterns:* Elijah F. Parker, Proctorsville, Vermont.

Claim.—"I am aware that offsetts have been turned on the frames of lanterns, for holding the glass, &c., but the corner pieces are made up of two or more pieces soldered

together: this I do not claim: but what I do claim as my invention is, the turning of grooved or sunken flanches upon the frames of lanterns, so that when the top and bottom are united, the flanches for holding the glass, mica, or their equivalents, shall be already in place to receive them, without any further soldering, substantially as herein described."

3 For an *Improved Screw Wrench;* George B. Read, City of New York.

"The nature of my invention consists in having the shank of the adjustable jaw pass through a recess in the stationary jaw, which is attached by a pivot to the end of the wrench stock; the shank of the adjustable jaw is provided with a rack, into which a pawl attached to the end of the wrench stock catches."

Claim.—"I do not claim having the jaw attached to a shank, and the shank passing through a recess in the jaw, independent of the mode of operating the jaws, for the above device, differently modified, as employed in various wrenches now in use; but what I claim as new is the arrangement of the several parts, as herein shown and described, viz: the jaw being attached by a pivot to the stock, and said jaw having a recess through it, through which recess the shank of the adjustable jaw passes—the shank being provided with a rack, into which a pawl attached to the end of the stock catches—said pawl being kept into the rack by the spring, by which arrangement, the two jaws are forced against the side of the nut, as the handle of the wrench is turned, and the jaws made to bear or bind harder upon or near the corners of the nut, thus preventing the jaws from slipping around it."

4. For an *Improvement in Portable Gas Apparatus;* William and Matthias Stratton, Philadelphia, Pennsylvania.

"The nature of our improvement consists in constructing a stove retort, and cooler, all arranged, so as to be portable, in the strict sense of the term, which may be used for the manufacture of illuminating gas from rosin or other suitable material."

Claim.—"Having described our portable gas apparatus, what we claim as our invention is, in the construction of the stove, of removable gates in the ends for the introduction of the retort, and the movable section under the rosin holder, in the manner as set forth and shown."

5. For an *Improvement in the Mode of Feeding Rosin in the Fires of Glass Furnaces;* Benjamin Shiverick, North Sandwich, Massachusetts.

Claim.—"I claim the combining the long conical valve and the discharge tube, by means of a set screw and nut and supporting spring, whereby the flow of the melted rosin may not only be regulated, but when any interruption takes place, the attendant can readily remove the same, either by lifting the valve or pressing on it, and such valve be subsequently moved back to its former position by the spring; this improvement being a very important one in the operation of the apparatus."

6. For an *Improvement in Manufacture of Indian Rubber;* Richard Solis, New Brunswick, New Jersey.

"The nature of my invention is the art of remanufacturing what is commonly known and called metallic, vulcanized, or insoluble rubber."

Claim.—"I therefore claim as my invention the manufacture of india rubber fabrics by the mixture of ground or powdered vulcanized rubber, with the ordinary india rubber of commerce."

7. For an *Improvement in Voltaic Batteries and Apparatus for Medical and other Purposes;* Issac L. Pulvermacher, Breslau, Prussia; patented in Austria, Oct. 9, 1849.

Claim.—"I do not claim, simply, making galvanic elements of negative and positive metals, with porous, non-conducting substance interposed, as in the well known galvanic pile; what I do claim as my invention is, constructing galvanic elements of positive and negative metals, separated from each other, by a porous, non-conducting substance, when the said porous, non-conducting substance is surrounded and held by one or both the said metals, substantially as specified and for the purpose specified. I also claim forming the galvanic elements, by coiling, in the form of helices, the positive and negative wires, in grooves, previously made in the surface of an inner core of wood, or other porous substance, substantially as specified, so that when the wires are wrapped around in the said grooves, they shall both be in contact with porous substance within, and separated from each other as specified. I also claim, forming a chain of a series of elements, substantially such as herein described, by means of ties or links, substantially as and for the purpose specified. And

finally, I claim the method of interrupting the current of electricity, by means of the spring vibrating conductor interposed, substantially as herein described, for the purpose of breaking and closing the circuit, by the movement of the human body, or other like motion, as set forth."

FEBRUARY 8TH.

8. For an *Improvement in Purifying Fatty Matters:* Jean Baptiste Moinier and Pierre Hyppolyte Boutigney, Paris, France; patented in France, November 14, 1849.

Claim.—"What we claim as our invention and discovery is, the introduction and mingling of a current or currents of sulphurous acid gas, with mixtures of fatty acids and alkalies, preparatory to the process of being converted into candles, tapers, and articles for burning, thereby rendering such mixtures of a superior quality, and causing them to burn with a stronger, clearer, and brighter light."

9. For an *Improvement in Hot Air Furnaces;* Nathaniel A. Boynton, Boston, Mass.

Claim.—"I do not claim a hollow ring radiator, placed over and made to communicate with the chamber of combustion; but what I do claim is the hollow "wheel radiator," made with a hollow rim, hollow spokes, a hollow hub (open at top and bottom), and a valve and valve seat, so made and applied to the hub, that when the valve is closed, it shall cause the heat and volatile products of combustion to pass through one or more of the arms, and into and through the hollow rim, and thence out of the said rim, through the other arm or arms, and into the hub, and over the valve, and also, so that when the said valve is opened, the heat and volatile products of combustion may pass directly up through the hub, without first circulating through the hollow arms and rim, substantially as specified."

10. For *Improved Arrangement of Centre Board and Rudder for Shoal Water Vessels;* George Chase, Prudence Island, Rhode Island.

Claim.—"I am aware that one rudder, made to slide within the other, and attached to centre board, has been used, so that one shall rise with the other; but in this case, there is no indication by which it can be known when the sliding rudder is up or down, and when used; thus I lay no claim to them; but what I do claim is, attaching the rear end of the movable centre board and the rudder to the sliding stern post, so that the said centre board, stern post, and rudder, may be raised or lowered together, substantially as described, and by which means, I only use a single rudder, whose position can always be known by the height of the stern post to which it is hung, as also that of the centre board; the sliding stern post serving as an indicator to the positions of both."

11. For an *Improvement in Hanging Farm Gates;* John Filson, Milroy, Penn.

Claim.—"What I claim as my invention is, the lower double jointed hinge, in combination with the apparatus attached to and constituting the upper hinge, for the purpose of holding the gate at any inclination required, for the purpose set forth."

12. For *Improvements in Core Bars for Forming Cores for Casting Pipes;* George Peacock, West Troy, New York.

"The nature of my invention consists in providing a lozenge shaped iron bar, having semicircular or other shaped wings or projections on its lower half; said bar, which I term the core bar, is fitted with a core box, and the sand packed and adjusted around it; the wings or semicircular projections binding the sand and causing it to adhere to the lower portion of the bar. The sand is placed over the upper portion of the bar, and rounded or shaped perfectly semicircular, by meansof a sweep. The bar, when properly encompassed by the sand, forms the core. The core bar may be so arranged, as to be adopted to form cores for elbows, branch pipes, &c., &c., and also be properly anchored, so as to allow pipes of any desired length to be cast."

Claim.—"Having thus described my invention, what I claim as new is, the core bar, having transverse wings or projections of semi circular or other shape, corresponding to the shape of the article to be cast; said wings or projections permitting the sand to be rammed, for forming the lower half of the core, and holding or binding the sand to the lower part of the bar, and allowing the upper half of the core to be made by the sweep, as herein set forth. I also claim the manner of anchoring the core bar, viz: by means of the metal strips or bridges fitting in recesses in the upper surface of the core bar; said bridges resting upon wooden supports, and having anchor rods bearing upon their upper surfaces, the liquid metal burning out the wooden supports and allowing the core to be withdrawn, by which means the core is prevented from being raised or forced upward, by the liquid metals, as it is poured into the mould; and thus enabling pipes to be cast of any desired

length. I also claim the manner, substantially as herein described, of connecting or jointing the core bars, for forming cores for elbows or branch pipes, viz: by means of wooden wedges, which are the means of holding the bars together while the core is being formed; said wedges being burnt out by the liquid metal, when poured into the mould, and allowing the cores to be withdrawn."

13 For an *Improvement in Moulds for Uniting Steel to Cast Iron;* Charles Peters, Trenton, New Jersey.

Claim.—"What I claim as my invention is, the use of a solid base to moulds, in which steel or wrought iron is to be welded to cast iron, with an aperture in the same, so that by means thereof, the said steel or wrought iron can be subjected to the heat of the furnace, while in the mould."

14. For an *Improvement in Winnowers;* George F. S. Zimmerman, Charlestown, Va.

Claim.—"Having fully described the construction, operation, and advantages of my improved threshing and cleaning machine, what I claim as new is, the invention, use, and application of the perforated vibrating table, arranged to a sloping bottom, or platforms, the parallel, saw like strips, or straw pushers, combined with an oscillating rake and straw beaters, or curved prongs; the whole combined and working with the oscillating hinged standard and suspending straps, as shown in diagram and substantially as set forth. I do not, however, claim the invention of a combined threshing, separating, and winnowing machine, but only such parts as are set forth in my specification."

15. For an *Improvement in Gas Metres;* Edward R. Hallam, and Thomas B. Barnard, Brooklyn, New York, Assignors to E. R. Hallam, New Haven, Connecticut.

Claim.—"What we claim as our invention is, the within described method of constructing metres, with one cylinder working within another, so that the gas passes alternately into the inner cylinder and out of the space above it, and then out of the inner cylinder, while the supply enters the space above it; the gas being changed in its course or direction, by valves, as herein described."

16. For an *Improvement in Surgical Instruments for Examining the Ear, &c.;* H. Le Riemondie, of New Orleans, Louisiana; ante-dated October 23, 1852.

"The object of my invention is so to construct such an instrument, that the part to be examined, is seen by light reflected upon it from the interior of the instrument."

Claim.—"What I claim as my invention is, the construction of an instrument for examining the interior of the ear, nose, eye, or other part of the human system, by the combination of the reflectors, the lens, case, tubes, and lamp, substantially in the manner herein specified."

MECHANICS, PHYSICS, AND CHEMISTRY.

On the Physical Lines of Magnetic Force. By Prof. FARADAY.*

On a former occasion, certain lines about a bar magnet were described and defined, (being those which are depicted to the eye by the use of iron filings sprinkled in the neighborhood of the magnet,) and were recommended as expressing accurately the nature, condition, direction, and amount of the force in any given region either within or outside of the bar. At that time the lines were considered in the abstract. Without departing from or unsettling anything then said, the inquiry is now entered upon, of the possible and probable *physical existence* of such lines. Many powers act manifestly at a distance; their physical nature is incomprehensible to us: still we may learn much that is real and positive about them, and amongst other things something of the condition of the space between the body acting and that acted upon, or between the two mutu-

* From the London Athenæum, July, 1852.

ally acting bodies. Such forces are presented to us by the phenomena of gravity, light, electricity, magnetism, &c. These when examined will be found to present remarkable differences in relation to their respective lines of forces; and at the same time that they establish the existence of real physical lines in some cases, will facilitate the consideration of the question as applied especially to magnetism. When two bodies, *a*, *b*, gravitate towards each other, the line in which they act is a straight line, for such is the line which either would follow if free to move. The attractive force is not altered, either in *direction* or *amount*, if a third body is made to act by gravitation or otherwise upon either or both of the first two. A balanced cylinder of brass gravitates to the earth with a weight exactly the same, whether it is left like a pendulum freely to hang towards it, or whether it is drawn aside by other attractions or by tension, whatever the amount of the latter may be. A new gravitating force may be exerted upon *a*, but that does not in the least affect the amount of power which it exerts towards *b*. We have no evidence that *time* enters in any way into the exercise of this power, whatever the distance between the acting bodies, as that from the sun to the earth, or from star to star. We can hardly conceive of this force in one particle by itself; it is when two or more are present that we comprehend it: yet in gaining this idea we perceive no difference in the character of the power in the different particles; all of the same kind are *equal*, *mutual*, and *alike*. In the case of gravitation, no effect which sustains the idea of an independent or physical line of force is presented to us; and as far as we at present know, the line of gravitation is merely an ideal line representing the direction in which the power is exerted. Take the sun in relation to another force which it exerts upon the earth, namely, its illuminating or warming power. In this case rays (which are lines of force) pass across the intermediate space; but then we may affect these lines by different media applied to them in their course. We may alter their direction either by reflection or refraction; we may make them pursue curved or angular courses. We may cut them off at their origin, and then search for and find them before they have attained their object. They have a relation to *time*, and occupy eight minutes in coming from the sun to the earth: so that they may exist independently either of their source or their final home, and have in fact a clear, distinct physical existence. They are in extreme contrast with the lines of gravitating power in this respect; as they are also in respect of their condition at their terminations. The two bodies terminating a line of gravitating force are alike in their actions in every respect, and so the line joining them has like relations in both directions. The two bodies at the terminals of a ray are utterly unlike in action: one is a source, the other a destroyer of the line; and the line itself has the relation of a stream flowing in one direction In these two cases of gravity and radiation, the difference between an abstract and a physical line of force is immediately manifest. Turning to the case of static electricity, we find here attractions (and other actions) at a distance as in the former cases; but when we come to compare the attraction with that of gravity, very striking distinctions are presented, which immediately affect the question of a physical line of force. In the first place, when we examine the bodies bounding or terminating the lines of attraction, we

find them as before, mutually and equally concerned in the action; but they are not alike: on the contrary, though each is endued with a force which, speaking generally, is of the like nature, still they are in such contrast that their actions on a third body in a state like either of them are precisely the reverse of each other,—what the one attracts the other repels; and the force makes itself evident as one of those manifestations of power endued with a dual and antithetical condition. Now with all such dual powers, attraction cannot occur unless the two conditions of force are present and in face of each other through the lines of force. Another essential limitation is, that these two conditions must be exactly equal in amount, not merely to produce the effects of attraction, but in every other case; for it is impossible so to arrange things that there shall be present or be evolved more electric power of the one kind than of the other. Another limitation is, that they must be in physical relation to each other; and that when a positive and a negative electrified surface are thus associated, we cannot cut off this relation except by transferring the forces of these surfaces to equal amounts of the contrary forces provided elsewhere. Another limitation is, that the power is definite in amount. If a ball *a* be charged with 10 of positive electricity, it may be made to act with that amount of power on another ball *b* charged with 10 of negative electricity; but if 5 of its power be taken up by a third ball *c* charged with negative electricity, then it can only act with 5 of power on ball *a*, and that ball must find or evolve 5 of positive power elsewhere: this is quite unlike what occurs with gravity, a power that presents us with nothing dual in its character. Finally, the electric force acts in curved lines. If a ball be electrified positively and insulated in the air, and a round metallic plate be placed about 12 or 15 inches off, facing it and uninsulated, the latter will be found, by the necessity mentioned above, in a negative condition; but it is not negative only on the side facing the ball, but on the other or outer face also, as may be shown by a carrier applied there, or by a strip of gold or silver leaf hung against that outer face. Now, the power affecting this face does not pass through the uninsulated plate, for the thinnest gold leaf is able to stop the inductive action, but round the edges of the face, and therefore acts in curved lines. All these points indicate the existence of physical lines of electric force:—the absolutely essential relation of positive and negative surfaces to each other, and their dependence on each other, contrasted with the known mobility of the forces, admit of no other conclusion. The action also in curved lines must depend upon a physical line of force. And there is a third important character of the force leading to the same result, namely, its affection by media having different specific inductive capacities. When we pass to dynamic electricity, the evidence of physical lines of force is far more patent. A voltaic battery having its extremities connected by a conducting medium, has what has been expressly called a current of force running round the circuit, but this current is an axis of power having equal and contrary forces in opposite directions. It consists of lines of force which are compressed or expanded according to the transverse action of the conductor, which changes in direction with the form of the conductor, which are found in every part of the conductor, and can be taken out from any place by channels properly appointed for the purpose; and nobody doubts that they are physical lines of force. Finally, as

regards a magnet, which is the object of the present discourse. A magnet presents a system of forces perfect in itself, and able, therefore, to exist by its own mutual relations. It has the dual and antithetic character belonging to both static and dynamic electricity; and this is made manifest by what are called its polarities, *i. e.* by the opposite powers of like kind found at and towards its extremities. These powers are found to be absolutely equal to each other; one cannot be changed in any degree as to amount without an equal change of the other; and this is true when the opposite polarities of a magnet are not related to each other, but to the polarities of other magnets. The polarities or the *northness* and *southness* of a magnet, are not only related to each other, through or within the magnet itself, but they are also related externally to opposite polarities, (in the manner of static electric induction,) or they cannot exist; and this external relation involves and necessitates an exactly equal amount of the new opposite polarities to which those of the magnet are related. So that if the force of a magnet *a* is related to that of another magnet *b*, it cannot act on a third magnet *c* without being taken off from *b*, to an amount proportional to its action on *c*. The lines of magnetic force are shown by the moving wire to exist both within and outside of the maget; also they are shown to be closed curves passing in one part of their course through the magnet; and the amount of those within the magnet at its equator is exactly equal in force to the amount in any section including the whole of those on the outside. The lines of force outside a magnet can be affected in their direction by the use of various media placed in their course. A magnet can in no way be procured having only one magnetism, or even the smallest excess of northness or southness one over the other. When the polarities of a magnet are not related externally to the forces of other magnets, then they are related to each other: *i. e.* the northness and southness of an isolated magnet are externally dependent on and sustained by each other. Now, all these facts, and many more, point to the existence of physical lines of force external to the magnets as well as within. They exist in curved as well as in straight lines; for if we conceive of an isolated straight bar magnet, or more especially of a round disk of steel magnetized regularly, so that its magnetic axis shall be in one diameter, it is evident that the polarities must be related to each other externally by curved lines of force: for no straight line can at the same time touch two points having northness and southness. Curved lines of force can, as I think, only consist with physical lines of force. The phenomena exhibited by the moving wire confirm the same conclusion. As the wire moves across the lines of force, a current of electricity passes or tends to pass through it, there being no such current before the wire is moved. The wire when quiescent has no such current, and when it moves it need not pass into places where the magnetic force is greater or less. It may travel in such a course that if a magnetic needle were carried through the same course it would be entirely unaffected magnetically, *i. e.*, it would be a matter of absolute indifference to the needle whether it were moving or still. Matters may be so arranged that the wire when still shall have the same diamagnetic force as the medium surrounding the magnet, and so in no way cause disturbance of the lines of force passing through both; and yet when the wire moves, a current of electricity shall be generated in it. The mere fact of motion

cannot have produced this current: there must have been a state or condition around the magnet and sustained by it, within the range of which the wire was placed; and this state shows the physical constitution of the lines of magnetic force. What this state is or upon what it depends cannot as yet be declared. It may depend upon the ether, as a ray of light does, and an association has already been shown between light and magnetism. It may depend upon a state of tension, or a state of vibration, or perhaps some other state analogous to the electric current, to which the magnetic forces are so intimately related. Whether it of necessity requires matter for its sustentation will depend upon what is understood by the term *matter*. If that is to be confined to ponderable or gravitating substances, then matter is not essential to the physical lines of magnetic force any more than to a ray of light or heat; but if in the assumption of an ether we admit it to be a species of matter, then the lines of force may depend upon some function of it. Experimentally mere space is magnetic; but then the idea of such mere space must include that of the ether, when one is talking on that belief; or if hereafter any other conception of the state or condition of space rise up, it must be admitted into the view of that, which just now in relation to experiment is called mere space. On the other hand, it is, I think, an ascertained fact, that ponderable matter is not essential to the existence of physical lines of magnetic force.—*Trans. Roy. Insti. June 11th*, 1852.

For the Journal of the Franklin Institute.

Speed of the Transatlantic Steamships, during the year 1852. By B. F. Isherwood, Chief Eng. U. S. Navy.

Finding it necessary for my own information to know the fair average performances of the Atlantic steamships for the last year, I constructed the following tables, in which "the longest," "the shortest," and the "mean passage" are given, with the speed per hour in geographical miles of 6982⅔ feet, at which the mean passage was made. The time of making the passage is the *true* time, not the apparent; 4 hours and 45 minutes being allowed as the difference between the American and British ports. The speed of the vessels per hour is calculated for the following distances, viz:

New York (battery) to Liverpool,	3084	geo. miles
Boston to Liverpool, via Halifax,	2883	"
New York to Cowes,	3120	"
New York to Glasgow,	3000	"
Philadelphia to Liverpool,	3250	"

In remarking the speeds of the screw vessels plying between Liverpool and Philadelphia, it must be borne in mind, that the time given, and from which the speed is computed, is from dock to dock; and that the latter city being situated on the Delaware river 110 miles from the ocean capes, obstructions are frequent in its navigation, from fogs, ice, narrowness of the channel, &c., causing occasional detentions, which being included in the time given, make the vessel's speed appear somewhat less than the truth. The steamers plying to New York and Boston suffer detentions from these causes in a less degree.

Table of Passages made by the Boston branch of the Cunard line of Steamships, for the eleven months commencing Jan. 1st, 1852, and ending Nov. 30th, 1852.

Name of Vessels.	From Boston to Liverpool.					From Liverpool to Boston.				
	No of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles per hour.	No of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles per hour.
Canada,	7	13 4 15	10 11 45	11 6 23	10·6628	6	12 23 30	10 10 15	11 6 7	10·6730
Cambria,	3	13 3 15	11 3 15	11 22 55	10·0477	2	15 14 18	12 7 15	13 23 00	8·6060
America,	7	12 12 45	10 18 15	11 13 2	10·4068	8	15 22 30	10 19 15	12 7 3	9·7712
Europa,	1	11 6 45	11 6 45	11 6 45	10·6482	1	15 2 15	15 2 15	15 2 15	7·9641
Niagara,	6	13 15 45	10 17 00	12 1 40	9·9528	6	14 2 00	11 22 25	12 11 42	9·6196
Means,				11 15 14	10·3248				12 8 9	9·7350

Table of the Passages made by the New York and Liverpool Steamships for the eleven months commencing Jan. 1st, 1852, and ending Nov. 30th, 1852.

COLLINS LINE.

Names of vessels.	From New York to Liverpool.					From Liverpool to New York.				
	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles. per hour.	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles per hour.
		d. h. m.	d. h. m.	d. h. m.			d. h. m.	d. h. m.	d. h. m.	
Pacific,	7	13 15 43	10 19 45	11 14 41	11·6048	6	14 21 30	9 21 15	11 10 33	11·2399
Atlantic,	6	12 6 35	10 10 45	10 23 17	11·7138	5	14 13 15	10 0 30	11 5 33	11·4413
Arctic,	6	11 11 15	10 3 00	10 22 3	11·7687	7	13 14 30	10 1 15	11 5 19	11·4511
Baltic,	4	12 23 45	10 14 15	11 10 52	11·2198	4	11 14 15	10 10 45	11 1 21	11·6224
Means,				11 5 40	11·4362				11 6 14	11·4125
CUNARD'S LINE.										
Asia,	7	13 2 45	10 9 55	11 8 51	11·3029	8	12 23 45	10 14 45	11 14 37	11·0688
Africa,	8	12 15 35	10 14 45	11 5 19	11·4511	7	13 15 15	10 7 15	11 13 52	11·0980
Means,				11 6 58	11·3813				11 14 16	11·0828
Niagara,	1	12 0 15	12 0 15	12 0 15	10·6990					
Canada,	1	11 22 00	11 22 00	11 22 00	10·7832	1	17 16 30	17 16 30	17 16 30	7·2666
Europa,	7	12 15 45	11 1 00	11 19 36	10·8745	7	12 15 15	10 22 45	11 20 45	10·8305
Means,				11 20 23	10·8446				12 14 13	10·2044

As the *Asia* and *Africa* are the only two vessels of the Cunard line, that for size and power can be put in competition with the Collins steamers, it is proper to confine any comparison to them alone—and from the above table it appears, that the mean passage of the Collins steamers from New York to Liverpool was only 1 hour and 18 minutes *shorter* than the mean passage of the Cunard line. The mean passage of the Collins steamers from Liverpool to New York was 8 hours and 2 minutes *shorter*

than the mean passage of the Cunard line. It thus appears that in both directions the Collins steamers have made the greatest speed, but in so very slight a degree over their competitors as to be scarcely entitled to the name of victory. Indeed, the mean of the passages from New York to Liverpool may be considered identical when the great distance traversed is taken into consideration; and the difference of 8 hours 2 minutes required by the Cunard line to make the passage from Liverpool to New York, in which head winds and seas are encountered in a greater proportion than in the other direction, may be ascribed to the greater resistance offered by their fuller bows above water, and the greater quantity of their spars and rigging. It is well known that the average consumption of coal by the vessels of both lines per voyage is about 900 tons; the paddle wheels are substantially the same, and the losses of effect from them about equal. The steam is used, however, in the Collins vessels at a higher rate of expansion than in the Cunarders, but the mean effective pressure in both is about the same. We are not therefore entitled to ascribe any decided superiority to either in wheels, engines, boilers, or model, but in the kind of rig, and in keeping the bow lines sharp high above water, so as to diminish the resistance of the vessel when struck by head seas. The arrangement of the Collins vessels seems to be the most judicious.

The three vessels, *Niagara*, *Canada*, and *Europa*, (comprising with the *Asia* and *Africa*, the New York branch of the Cunard line,) though of much inferior size and power to the Collins steamers, have nevertheless maintained a high rate of speed; the mean of their passages from New York to Liverpool being only 14 hs. and 43 mins. longer than the mean of the Collins passages in the same direction. The one westerly passage made by the *Niagara*, in which she broke down and put into Halifax, has been omitted; and if we omit also the exceptional single passage of the *Canada*, and confine ourselves to the mean of the *Europa's* passages from Liverpool to New York, we shall find it but 14 hours and 31 minutes longer than the mean of the corresponding Collins passages.

Table of the Passages made by the New York and Havre, and by the New York and Bremen Steamships, between New York and Cowes, for the eleven months commencing Jan. 1st, 1852, and ending Nov. 30th, 1852.

Names of vessels.	From New York to Cowes.					From Cowes to New York.				
	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles per hour.	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles per hour.
New York and Havre Line.		d. h. m.	d. h. m.	d. h. m.			d. h. m.	d. h. m.	d. h. m.	
Franklin,	5	13 4 45	10 17 45	11 18 51	11·0306	4	12 7 45	10 3 15	11 12 30	11·2840
Humboldt,	5	16 0 15	11 11 30	13 9 12	9·7136	4	13 1 15	11 4 45	12 2 00	10·7586
New York and Bremen Line.										
Washing.	6	22 4 45	13 4 45	15 10 55	8·4115	5	15 3 15	13 12 15	14 8 45	9·0500
Hermann,	4	13 15 55	12 6 45	13 1 44	9·9449	4	13 4 45	11 10 15	12 5 55	10·6151

Table of the Passages made by the New York and Glasgow Screw Steamship **Glasgow,** *plying between New York and Glasgow, for the eleven months commencing Jan.* **1st,** **1852,** *and ending Nov.* **30th,** **1852.**

Name of vessel.	From New York to Glasgow.					From Glasgow to New York.				
	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles per hour.	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles per hour.
		d. h. m.	d. h. m.	d. h. m.			d. h. m.	d. h. m.	d. h. m.	
Glasgow,	6	15 16 5	12 21 45	14 18 5	8·7099	5	14 22 15	12 12 15	14 4 59	9·0448

Table of the Passages made by the Philadelphia and Liverpool Screw Steamships, for the eleven months commencing Jan. **1st,** **1852,** *and ending Nov.* **30th,** **1852.**

Names of vessels.	From Philadelphia to Liverpool.					From Liverpool to Philadelphia.				
	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles per hour.	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles per hour.
		d. h. m.	d. h. m.	d. h. m.			d. h. m.	d. h. m.	d. h. m.	
City of Gl.	7	18 19 45	15 10 15	16 8 36	7·1942	6	23 20 45	13 18 25	16 21 2	8·0237
C. of M'r.	6	18 4 15	13 3 45	15 23 49	8·4783	5	17 11 21	13 12 15	15 6 44	8·8621

It has generally been supposed that the *very weak* point of the screw propeller, compared with the paddle wheel, was its inability to proportionally maintain the speed of the vessel against head winds and seas; in other words, that the difference between the speeds of the screw vessel in going with the wind and against the wind, was very much greater than the difference between the speeds of the paddle wheel vessel in the same circumstances. Now, it is known that for the greater part of the year, westerly winds and seas prevail; therefore, the foregoing tables should show in a marked manner this characteristic of the screw, if it exist. No such difference, however, can be observed; on the contrary, taking the three screw steamships *Glasgow*, *City of Glasgow*, and *City of Manchester*, the mean of the westerly passages of the first is actually 13 hours and 6 minutes *shorter* than the mean of the easterly passages. This, of course, throws out the exceptional passage of February, when the *Glasgow* was obliged to put into Halifax, and was 22 days making the voyage; but even including this passage, the mean westerly voyage is but 13 hours and 47 minutes *longer* than the mean easterly one. The mean westerly passage of the second, the *City of Glasgow*, is only 12 hours and 26 minutes *longer* than the mean easterly passage; while the mean westerly passage of the third, the *City of Manchester*, is 17 hours and 5 minutes *shorter* than the mean easterly passage. From the foregoing tables, then, it appears that no greater difference exists between the speed of these screw

vessels going with and against the weather, than between the speeds of the paddle wheel vessels under the same circumstances. That strong westerly winds prevail for the greater part of the year, between our Atlantic ports and the British islands, is proven by the fact, that the sailing packets are from one and a half to twice as long making the westerly as the easterly passage.

Table showing the mean speeds of the Atlantic Steamships for the Easterly and for the Westerly Passages; and also the mean Speed of the Easterly and Westerly passages; for the eleven months commencing Jan. 1st., 1852, and ending Nov. 30th, 1852.

PADDLE WHEEL STEAMERS.

Name of vessels.	Easterly passages; mean speed in geographic. miles per hour.	Westerly passages; mean speed in geographic. miles per hour.	Mean speed of the easterly and westerly passages in geo. miles per hr.	Names of vessels.	Easterly passages; mean speed in geographic. miles per hour.	Westerly passages; mean speed in geographic. miles per hour.	Mean speed of the easterly and westerly passages in geo. miles per hr.
Canada,	10·6778	10·1864	10·4489	Pacific,	11·6048	11·2399	11·4364
Cambria,	10·0477	8·6060	9·4710	Atlantic,	11·7138	11·4413	11·5899
America,	10·4068	9·7712	10·0678	Arctic,	11·7687	11·4511	11·5977
Europa,	10·8462	10·4722	10·6592	Baltic,	11·2198	11·6224	11·4211
Niagara,	10·0594	9·6196	9·8564	Franklin,	11·0306	11·2840	11·1432
Asia,	11·3029	11·0688	11·1780	Humboldt,	9·7136	10·7586	10·1780
Africa,	11·4511	11·0980	11·2863	Washington,	8·4115	9·0500	8·7017
				Hermann,	9·9449	10·6151	10·2800
SCREW STEAMERS.							
Glasgow,	8·7099	9·0448	8·8621	City of Glasgow,	7·1942	8·0237	7·5770
				" Manchester.	8·4783	8·8621	8·6528

For the Journal of the Franklin Institute.

A Plan for Aerial Navigation by means of Steamers, without the aid of a Balloon. By THEODORE POESCHE.

The old problem of the navigation of the air, which has been agitated for thousands of years, is apparently on the eve of solution. For seventy years our balloons have floated in the air like ships without a rudder, and without the possibility of control. In more recent times, steam has been employed to propel the balloon, thus making it possible at the same time to direct it. A vessel of this description was launched into the atmosphere at the Hippodrome of Paris, a few weeks ago, and tacked at pleasure.

I would now submit to the consideration of adepts, a plan for dispensing with the support of a balloon. This suggestion may be regarded as an improvement upon our present aerial navigation; but it may with equal or greater propriety be looked upon as an advanced stage of nautical travel. I take a modern steamer in its most perfect form, and propose such modifications as will enable it to pierce the air in the same manner as it now scuds over the water. In the age of the magnetic telegraph, which must shortly encircle and centralize the whole earth's surface, aerial navigation becomes a logical necessity; the wires are the nerves

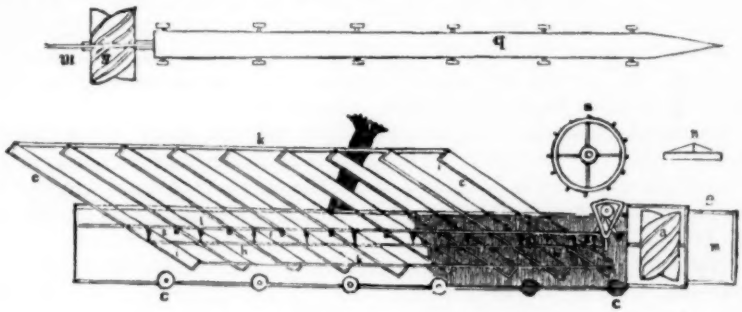
of humanity, which unite its sensations; they imperatively call for corresponding organs of motion, such as only the air-ship affords. I publish the plan, in order to hear the opinions of those who are competent to decide; the common interest of humanity cannot be better advanced than by their concerted mental labor. The problem in question most nearly concerns the common interest of the race, for it furnishes the only means for the attainment of their highest political, social, and intellectual development.

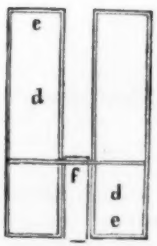
The prominent characteristics of our most modern ship building appear to me to be the following:

1, Their superior buoyancy. Iron ships are in increasing request for the ocean; they are 50 per cent. lighter than wooden ones. On rivers, the lightest species of craft are hooped boats, which have but half the weight of iron ships, or one-fourth of that of a wooden vessel of the same dimensions; they are constructed of light wooden planks, ribbed with iron hoops.

2, Their slender form; their proportions are approaching those of Indian canoes. The English steamer *Wave Queen* is 200 feet long, and but 13 feet wide, making the ratio 16 to 1. Her trips are of unequalled swiftness.

3, The almost universal introduction of the screw propeller, which must ere long do away with the paddle wheel altogether.





Starting upon these considerations, I propose to build a vessel of the least possible weight, long and narrow, making the relative proportions for a larger vessel 20 to 1. The ship to be propelled by a screw, *a*. The screw must work in the air with the same effect as in the water. The greater elasticity of the air will compensate for its want of density. The screw, however, is larger than that of a nautical vessel, and has 12 blades of boiler iron. The elasticity of the air permits this increase, as it will instantly rush in to fill the vacuum. Unlike the screw used for water, every blade of the screw used for the air shall have on its upper edge the strip of a cylindrical plane, the axis of which would coincide with that of the propeller, in order to prevent the too rapid escape of the air.

The ship has a flat bottom, *b*, upon which the sides rise perpendicu-

larly, and runs on broad wheels of short diameter, *c*. When the screw is put in motion by the engine, *the ship will run over the ground upon the wheels*. For the purpose of ascension, the ship is furnished at its sides with large inclined planes of double glued canvass, *d*, stretched upon iron frames, *e*, which act like the plane of a boy's kite. These planes turn upon iron axes, *f*, which are adjusted under the heavy beam of the deck, *g*. An iron rod, *h*, gives the means of turning these axes, and regulating the angle of inclination. Let them be fixed at an angle of 45°, and the vessel be propelled rapidly by means of the screw, and the air, compressed by their resistance, will lift the ship. To retard the escape of the air at the edges of the planes, it is necessary to attach narrow lateral planes to the frames projecting forwards at right angles, *i*. Thin iron rods connect the frames above and below, *k*, and a stronger one, *l*, the axes. The angle of the planes determines the ascension or declension of the ship; the lateral direction is conducted by means of a rudder, *m*, also consisting of double glued canvass, stretched upon an iron frame. As the ship is propelled rapidly forwards, the rudder must act upon the water as it would upon the air. The deck, *n*, tapers off at an angle of 140°. The sides must be particularly strengthened, to withstand the pressure from behind.

In conclusion I observe, that the flight of birds and insects depends upon the principle of the screw. The wing is a screw blade, which works up and down, and thus exerts the force of an inclined plane. As it is concave underneath, and convex above, it compresses the air below it, and thus supports the body of the animal. *My ship most nearly resembles the flying fish, which progresses by means of the spiral action of the tail, while its extended fins support it for a time in the air.*

Where the tonnage is the same, a vessel will not require more power in the air than in the water. The latter is necessarily heavier, and must expend, in overcoming the inertness and the adhesion of the water, nearly the same amount of waste force as the former, in compressing the air for its support.

We may possibly, in time, get a motive power more adapted for the purpose, such, for instance, as carbonic acid; but, however, the present improved steam engine seems to be entirely adequate to the purpose.

Philadelphia, January, 1853.

For the Journal of the Franklin Institute.

The United States Steamer Water Witch. By B. F. Isherwood, Chief Eng., U. S. Navy.

(*With a Plate.*)

The original *Water Witch* was a small *iron* vessel that had undergone several transformations in the Navy, until the hull becoming finally unseaworthy and condemned, while the engine remained good, a *wooden* hull was ordered to be built for it, with new boilers of the "sheet water space" or "Lamb and Summer" kind, and new overhung paddle wheels, with *perpendicular* paddles. The whole of the work, hull and machinery, was executed at the Washington Navy Yard. To render an account of

the performance of the vessel of value, it will be necessary to give the dimensions of the hull and machinery, which are as follows, viz:

HULL.

Length on water line at 7 feet 10 inches draft, in clear of rabbets,	150 feet.
Beam on deck, extreme,	23 "
Depth of hold,	11 " 6 inches.
Mean draft, with half coal in and other weights full,	7 " 10 "
Displacement at 7 feet 10 inches draft,	450 tons.
Displacement per inch of draft at 7 feet 10 inches draft,	6·09 "
Immersed amidship section at 7 feet 10 inches draft,	149·4 square feet.
Burthen,	393 tons.

ENGINE.—One inclined condensing engine, with balance puppet valves, cutting off with the steam valve by Sickels' arrangement.

Diameter of cylinder,	37½ inches.
Stroke of piston,	6 feet.
Space displacement of piston per stroke,	45 cubic feet.
Steam space between cut-off valve and piston, at one end of the cylinder,	2·25 "

PADDLE WHEELS.—Perpendicular paddle wheels, overhung.

Diameter from outside to outside of paddles,	19 feet.
Length of paddle,	5 "
Width of paddle,	36 inches.
Number of paddles in one wheel,	10.
Area of two paddles,	30 square feet.
Immersion of lower edge of paddles at 7 ft. 10 in. draft of water,	3 feet 6 inches.

BOILERS.—(Plate IV.)—Two iron boilers, with sheet water spaces. The boilers are placed side by side, with one smoke chimney in common; each boiler contains 14 flues, 45 inches high by 2 inches wide in the clear, and 66 inches long; the water spaces between the flues are 1 5-12 inch wide in the clear. The upper part of the front or furnace end of the flues is bricked *down* 18 inches from the top, for the purpose of forcing the heated gases to enter at the bottom. There is a permanent water space hanging bridge at the back end of the flues, for the purpose of retaining the heated gases in the top of the flues until the heat is sufficiently extracted to allow them to descend by their gravity, and pass under the bottom of the bridge into the chimney.

Length of each boiler,	18 feet 9 inches.
Breadth of each boiler,	6 "
Height of each boiler,	9 "
*Area of the total heating surface in the two boilers,	1831 square feet.
*Area of the total grate surface in the two boilers,	61 "
*Aggregate cross area of flues at front end, *below* the brick work, in the two boilers,	10·416 "
*Aggregate cross area of flues in the two boilers,	17·333 "
*Aggregate cross area between bottoms of hanging bridge and flues in the two boilers,	9·778 "
Cross area of the smoke chimney,	21·647 "
Height of the smoke chimney above the grates,	42 feet 9 inches.
Capacity of steam room in the two boilers,	467 cubic feet.
Weight of sea water contained in the two boilers, (by the scales,)	34,000 pounds.
Weight of the two boilers,	66,200 "

PROPORTIONS.

Proportion of heating to grate surface,	30·016 to 1·000
" grate surface to cross area of flues at front end, below the brick work,	5·856 "
" " " of flues,	3·519 "
" " " between bottoms of hanging bridge and flues,	6·239 "
" " " of smoke chimney,	2·818 "
Cubic feet of steam room per cubic foot of space displacement of piston per stroke,	10·378

* As used on the trip from Washington to Baltimore, and as finally adopted.

Performance at the Dock.—Before making the trial trip, the machinery was set in motion and worked at the Dock, to which the vessel was of course securely fastened. The top edge of the lowest paddle coincided with the level of the water, or the paddles were *awash*. In this condition, with a mean effective pressure of 24·6 pounds per square inch by indicator, the wheels made 11 revolutions per minute; and with a mean effective pressure of 16·15 pounds per square inch by indicator, the wheels made 9 revolutions per minute. It will be observed that the revolutions, 11 and 9, are nearly in the proportion of the square roots of the pressures, 24·6 and 16·15 pounds.

On the day of the first trial at the Dock, the furnaces were fired with the Cumberland bituminous coal, and steam began to form in one hour and five minutes, the temperature of the water being about 40° Fah. Owing, however, to defective packing of the valve stems, the working of the engine was discontinued until the next day, when the furnaces were again fired with Cumberland bituminous coal, and steam obtained in one hour from water of the temperature of 40° Fah.

During these experiments with Cumberland coal, it was remarked with surprise that no smoke issued from the chimney top, as in ordinary cases this fuel gives off a dense black smoke, especially in starting fires. On opening the door in the chimney, it was perceived that no smoke entered from the flues, and there was no external indication of bituminous coal being used, the appearance from the chimney being the same as if anthracite had been used; in fact, the combustion was perfect. In the furnaces, however, there was the ordinary appearance of smoke. To account for this result, so different from what ordinarily follows the combustion of this coal, it is necessary to glance at the manner in which it enters into ignition.

All coal being of vegetable origin, is composed of the same constituents, but in different proportions, as the vegetables from which it is formed; these constituents are carbon, hydrogen, and oxygen. In coal they are found mixed with a small per centage of earthy or metallic substances, which being incombustible, do not require to be considered. These constituents form new combinations with each other, the oxygen and hydrogen uniting with the carbon, and forming respectively carbonic acid gas and carburetted hydrogen gas. These combinations are constantly going on among the solid constituents of the coal, even at ordinary temperatures; and the gaseous products are continually passing off, producing in coal mines the *choke damp* and the *fire damp* of miners. Now, hydrogen ignites at a greatly less temperature than carbon, and when carburetted hydrogen gas is distilled in considerable quantities in the furnaces of a steam boiler, if the temperature be too low for the ignition of the carbon, but high enough for the ignition of the hydrogen, the latter will burn, that is, enter into chemical union with the oxygen of the atmospheric air, and forming vapor of water, liberating the carbon, which will be disengaged in the form of the solid, black, impalpable particles called smoke, and so pass off into the atmosphere, being a total loss of that much fuel, beside carrying with it the heat expended to give it the difference of temperature between what it had when it entered the furnaces and when it left the flues of the boilers. But if the temperature be

sufficiently high, the carbon will burn as well as the hydrogen; that is, will enter also into chemical combination with the oxygen of the atmosphere, and form carbonic acid gas, a colorless gas, which passes off by the chimney, and has of course no appearance of smoke. The oxygen disengaged from the coal, also being present, contributes to the formation of these compounds; but as much more than a sufficient quantity is, with ordinary proportions of boilers, admitted through the grates for that purpose, it would be useless, could it be prevented, to expend heat in distilling what can be already obtained without cost in the gaseous form.

From the foregoing it will be perceived, that the main cause of smoke is the want of a sufficient temperature to ignite the carbon; but even with this temperature, smoke would exist were the carbon not intimately mixed with oxygen, and this mixing evidently is greatly promoted by reverberations, eddies, and currents in the flues, with time to effect it; the want of these eddies and of time is a cause but little less important than too low temperature of the production of smoke in the furnaces and flues of steam boilers.

With bituminous coal, smoke always exists in the furnaces, though it sometimes disappears in the flues if a large body of the heated gases is kept together for a short time and exposed to comparatively little cooling surface; for by this arrangement the temperature is maintained and the mixing with oxygen effected. In the furnaces, where smoke always exists, the temperature is the highest, but time and currents are wanting for the mixture; for the gases pass off rapidly towards the flues in one unbroken mass as they are distilled from the coal. In general, the heated gases from a boiler furnace is exposed too soon, before time is had for mixing, to a comparatively large extent of heating surface, by which the temperature is at once lowered below the point of ignition, for the carbon and smoke produced. It is well known that smoke can be greatly prevented, and as a consequence, a saving of fuel effected, by firing with small or thin charges, as in this case not enough cold fuel is introduced at once to materially lower the temperature of the furnace over the grates. For the same reason, it is found judicious to fire one-half of a furnace at a time, covering it with fresh fuel, and leaving the surface of the remaining half in full ignition.

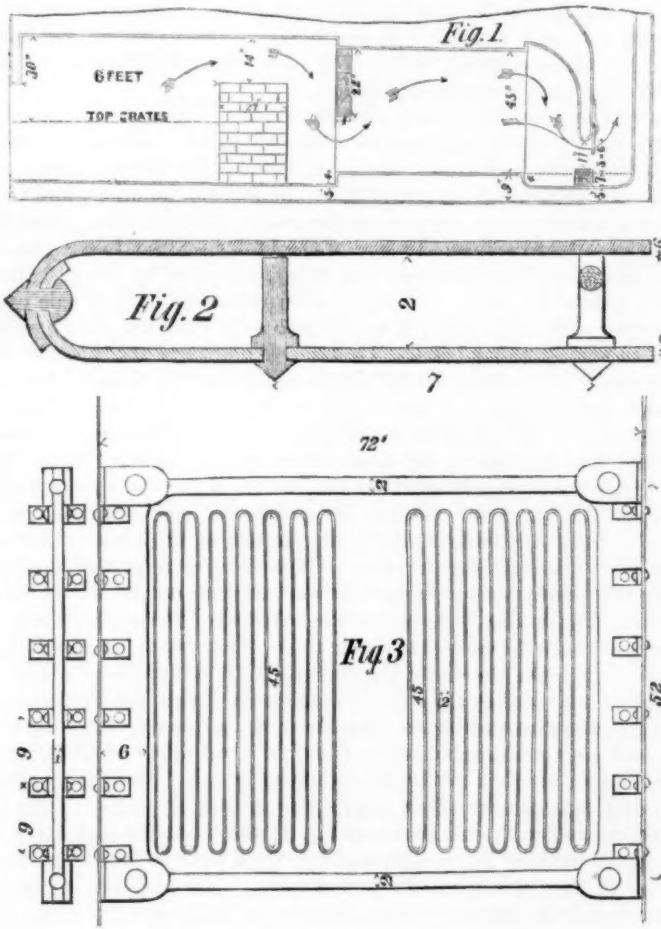
In the boilers of the *Water Witch*, the doors of each furnace were in pairs, extending across the whole width. The furnace was fired half at a time, one of the doors only being opened and the other remaining closed. The course of the heated gases was considerably changed, and they were exposed to several eddies and reverberations before they reached the chimney. After passing from the furnace over the brick bridge wall, they impinged directly against the brick work placed in the top of the front end of the flues, by which the current was turned directly downwards; after it had passed below this brick work, it rose by specific gravity to the top of the flues, undergoing another reverberation or eddy behind the bricks; and finally, after reaching the hanging bridge at the back end of the flue, it was again deflected downward, and made its escape beneath the bridge into the chimney. In addition to undergoing these eddies and reverberations, the gases were kept in large masses in the flues comparatively to the heating surface exposed to them in a given

time. The cubic contents of each flue is 3·4 cubic feet, and its heating surface is 42·3 square feet, or 12·441 square feet of surface per cubic foot of gas, while the distance to be traversed is only 5 feet 6 inches. Between the brick bridge and the flues the gases are kept in one undivided mass, and the brick bridge itself acts as a maintainer of equable temperature after it has once been heated up, giving out heat to the gases whenever their temperature falls below it.

While discussing the features of the boiler, it may be of value to give an account of an incident connected with its performances, showing how much the position of the draft opening affected the result. During the working of the engine at the Dock and on the succeeding trial trip, there was a brick wall (fig. 1) built up 7 inches high, immediately beneath the hanging bridge at the back of the flues, leaving 11 inches opening between the top of the wall and the bottom of the bridge. This was done with a view to contract the opening at that place, and prevent the gases from passing too rapidly into the chimney. After the trial trip, this wall was removed, and an iron plate was attached to the hanging bridge, depending 6 inches below it, leaving the distance between the bottom of this plate and the bottom of the back connexions 12 inches. On starting fires again to work the engine at the Dock, it was now found that the draft, which with the brick wall arrangement was very strong, burning about 12 pounds of hard Lackawanna anthracite per square foot of grate per hour, with 42¾ feet of smoke chimney above the grates, was almost wholly annihilated. Instead of 1 hour and 15 min. which had been required on the trial trip to get steam from water at 40° Fahr. with the same coal, there were now required three hours and a-half, and the after production of steam was as slow in proportion as its first generation, the boiler furnishing only about one-third the quantity of steam per unit of time as previously. On looking into the furnaces, the surface of the coal appeared dull and black, and the flame curled lazily around, as in a baker's brick oven; the chimney was cool, and every indication showed the draft to be stopped off; yet the only attention that had been made was the substitution of the plate for the wall, and shifting the opening 6 inches lower, while the opening itself had been increased one-eleventh. These modifications are shown in the accompanying sketch.

After a little consideration, I detected the difficulty; the error consisted in considering the distance of 12 inches between the bottom of the plate and the bottom of the back connexions as the effective opening, whereas the *effective* opening was only the vertical distance between the bottom of the plate and the line produced of the bottoms of the flues, shown dotted in the sketch. Reckoning this as the *effective* opening, it would only be 5 in. high, or an area to each furnace of 151·25 sq. in., while the area of each furnace grate was 2178 square inches, or the proportion was 1·0 of opening to 14·4 of grate surface; previously, during the experiments at the Dock and on the trial trip, this proportion, with the wall arrangement, was 1·000 to 6·546, or more than double. The plate was now removed, the wall was not restored, and the effect was again the same as on the trial trip, as the presence of the wall produced no result. On the passage from Washington to Baltimore the boiler was as shown in the large engraving.

By observing the sketch, it will be perceived there could exist no force to expel the air lying in the bottom of the back connexions below the line of the bottoms of the flues. That portion of the boiler being both the *lowest* and the *coolest*, and lying rectangularly below the current of hot gases issuing from the bottoms of the flues, the air contained in it could neither be *pushed* out by this current, nor be *heated* so as to rise by its diminished specific gravity and pass out with the general current up the chimney. The effect was the same as though the space beneath the dotted line had been filled with solid matter.



On trying the boilers with hard Lackawanna anthracite, they were found to require one hour and a quarter to make steam, and about two hours to bring the fires to steady, regular action. The anthracite was in lumps about the size of a large man's fist; the Cumberland coal was chiefly

fine, and both were of good quality. In starting fires, but a very small quantity of pine wood was used with either. The grate bars were — inches thick, with — inch air spaces between.

Bracing of the Boilers.—The bracing of this kind of boilers at the flues is peculiar; it is represented in fig. 2. The flat flues it will be observed are braced in the fire spaces, and *not* in the flat spaces, as in ordinary boilers. These braces are studs of wrought iron, with a collar on the inside abutting against one side of the flue; this side of the flue is punched, and the outer end of the stud passed through it and riveted over; the opposite side of the flue only abuts against or touches the other end of the stud, as the force to be withstood is that of compression solely. Of course, with this system, it is absolutely necessary to fit the boilers with an air valve opening inward by the atmospheric pressure, or a *vacuum valve*, as it is commonly called.

It is obvious on inspection, that the sides of the boilers cannot be braced from, or stayed to the sides of the side flues, because of the unbalanced pressure that would result on those flues; for the studs communicate the pressure from one side of the flue to the other, and if this other be again stayed to the side of the boiler, it is plain the pressure on one side of the flue and on the side of the boiler will be in the same direction; and these two pressures will only be resisted by the pressure on the other side of the flue. Now, as the pressures on each side of the flue balance each other only, it would leave the pressure on the side of the boiler wholly unbalanced. To brace the sides of the boilers, then, it is necessary to tie them across above and below the flues by heavy tie rods, and as this leaves the flat side for more than the depth of the flue unsupported, that side must be stiffened by a heavy vertical bar of wrought iron fastened to the side at the usual intervals for braces by lugs. These vertical bars are placed lengthways the boilers at the usual intervals for braces, and the heavy tie rods are fastened to the bars at top and bottom, unless the flues descend to nearly the bottom of the boiler, when that bottom becomes itself the tie rod. Of course, each pair of these rods must be sufficiently strong to sustain the pressure on the whole surface comprised longitudinally between the centres of the vertical bars and vertically between the centres of the tie rods. The system is shown in fig. 3.

Trial Trip.—On the 30th December, 1852, an engineer's trial trip was made from the Navy Yard at Washington down the Potomac river to Fort Washington and back. The Hon. Mr. Kennedy, Secretary of the Navy, and Commodore Shubrick, Chief of the Bureau of Construction, with a number of other gentlemen, were on board. The time occupied in running between the given points was accurately noted. The brick work of the boiler was as shown in fig. 1; the 7 inches high brick wall being under the hanging bridge, and the brick work in the top part of the front end of the flues being 22 inches *down*. The hinged hanging plate marked 6 inches, and depending below the hanging water bridge, was not on. The water was perfectly smooth. In running from the Navy Yard to the Fort, the tide, which is here without much influence at the strongest, was at the flood; the gentle southerly breezes were unfavorable. On the return, the tide was ebbing fast, but the same breezes as before were now favorable. The distance from the Arsenal (1½ miles below the Navy Yard)

to the Fort and back to the Arsenal, including turning, traversed by the vessel, is 21 miles. Time occupied in running it, 110 minutes; mean draft of the vessel 7¼ feet; immersion of the lower edge of the paddle, 2 feet 11 inches. The consumption of coal was ascertained by careful measurement. The speed as given by the *chip log* was large 9½ knots per hour, or 10·944 statute miles. It is well known that when the speed of a vessel exceeds 8 knots per hour, the indications of the chip log become too low.

Speed of vessel in statute miles per hour,	11·4545
Revolutions of the wheels per minute,	25
Slip of the centre of pressure of the paddles in per cents. of its speed,	24·63
Initial steam pressure in cylinder per square inch above atmosphere, by indicator,	18 pounds.
Steam cut off at from commencement of stroke of piston,	·36 or 2 feet 2 inches.
Consumption of Lackawanna anthracite per hour,	666 pounds.
Pounds of steam evaporated per hour from fresh water, with temperature of feed water 100° Fahr., by one sq. foot of heating surface,	2·429
Pounds of steam evaporated per hour from fresh water, with temperature of feed water 100° Fahr., by one pound of coal,	6·252
Cubic feet of steam of atmospheric pressure furnished per minute, from fresh water, with temperature of feed water 100° Fahr.,	1919·521
Pounds of coal burned per hour per square foot of heating surface,	0·383
" " " " " grate surface,	10·918
Mean effective pressure on piston per square inch, by indicator,	19·4 pounds.
Horses power developed by the engines,	194·78

Trip from Washington to Baltimore.—On this trip, the brick work of the boiler was as shown in the large engraving. The vessel drew 9 feet 5 inches forward and 8 feet 5 inches aft; mean draft 8 feet 11 inches, having 120 tons of Lackawanna anthracite on board, with full stores, &c. Immersion of lower edge of paddles, 4 feet 7 inches. The vessel was very badly trimmed, being a foot by the head. Left the Arsenal on the 15th January, 1853, at 7 hours 5 minutes, A. M., and steaming down the Potomac river, was abreast of Point Lookout at 7 hours 56 minutes P. M., the same day. Time 12 hs. and 51 m., from which there is to be deducted 1 hour and 10 minutes for stoppages to repack cut-off dash ports, leaving the running time 11 hours and 41 minutes. Distance by Chart 102 statute miles; smooth water and light fair winds. No *blowing off* done.

Result.	
Speed of vessel in statute miles per hour,	8·730
Revolutions of the wheels per minute, (by counter,)	18·264
Slip of the centre of pressure of the paddles in per cents. of its speed,	21·38
Initial steam pressure in cylinder per square inch above atmosphere by indicator,	11·3 pounds.
Steam cut off at from commencement of stroke of piston,	·62 or 3 feet 8⅝ inches.
Consumption of Lackawanna anthracite per hour,	631 pounds.
Pounds of steam evaporated per hour from fresh water, with temperature of feed water 100° Fahr., by one sq. foot of heating surface,	2·240 "
Pounds of steam evaporated per hour from fresh water, with temperature of feed water 100° Fahr., by one pound of coal,	6·500 "
Cubic feet of steam of atmospheric pressure furnished per minute from fresh water with temperature of feed water 100° Fahr.,	1859·222
Pounds of coal burned per hour per square foot of heating surface,	0·315
" " " " " grate surface,	10·344
Mean effective pressure on piston per square inch, by indicator,	18·5 pounds.
Horses power developed by the engine,	135·69

After rounding Point Lookout, the *Water Witch* proceeded up Chesapeake

Bay to Baltimore, against about half a gale of wind and considerable sea, and at 9 hours 50 minutes A. M., January 16th, stopped the engines and anchored in Baltimore harbor; distance from Point Lookout, 97 statute miles; time, 13 hours 54 minutes. During this half of the trip steam was carried as high as possible, and the performance of the boilers may be considered their maximum. No *blowing off* done.

RESULT.

Speed of the vessel in statute miles per hour,	6·978
Revolutions of the wheels per minute, (by counter,)	18·508
Slip of the centre of pressure of the paddles in per cents. of their speed,	37·98
Initial steam pressure in cylinder per square inch above atmosphere, by indicator,	22·3 pounds.
Steam cut off at from commencement of stroke of piston,	·59 or 3 feet 6½ inches.
Consumption of Lackawanna anthracite per hour,	909 pounds.
Pounds of steam evaporated per hour, from brackish water, with temperature of feed water 100° Fahr., by one square foot of heating surface,	2·995 "
Pounds of steam evaporated per hour, from brackish water, with temperature of feed water 100° Fahr., by one pound of coal,	6·033 "
Cubic feet of steam of atmospheric pressure furnished per minute, from brackish water, with temperature of feed water 100° Fahr.,	2486·080
Pounds of coal burned per hour, per square foot of heating surface,	0·497
" " " " " grate surface,	14·902
Mean effective pressure on piston per square inch by indicator,	25·7 pounds.
Horses power developed by the engine,	191·02

Trip from Baltimore to Norfolk.—On the arrival of the *Water Witch* at Baltimore, the grates were altered so as to be 7 feet instead of 6 feet long. This alteration involved no others, and the rest of the boilers remained as before. This change made the grate surface 71 square feet instead of 61 square feet. The vessel left Baltimore on the 19th Jan., 1853, at 11 hours 45 minutes, A. M., and anchored off the Navy Yard, Norfolk, at 7 o'clock A. M., Jan. 20th. On the passage several stoppages occurred from causes not connected with the machinery, involving a loss of one hour and a quarter, making the running time 18 hours. Distance by Chart, 190 statute miles; moderate wind and sea on the port quarter, but no sail set. The counter being out of order, the revolutions of the wheels were noted at regular intervals by the watch. Draft of vessel, 8 feet 9 inches forward, and 8 feet 10 inches aft; immersion of lower edge of paddles, 4 feet 5½ inches. No *blowing off* done.

RESULT.

Speed of the vessel in statute miles per hour,	10·556
Revolutions of the wheels per minute,	22·4
Slip of the centre of pressure of the paddles in per centums of their speed,	22·48
Initial steam pressure in cylinder per square inch above atmosphere,	18·3 pounds.
Steam cut off at from commencemen of stroke of piston,	·6 or 3 feet 7¼ inches.
Cousumption of Lackawanna anthracite per hour,	1090 pounds.
Pounds of steam evaporated per hour, from bay water, with the temperature of feed water 100° Fahr., by one square foot of heating surface,	3·313 pounds.
Pounds of water evaporated per hour, from bay water, with temperature of feed water 100° Fahr., by one pound of coal,	5·566 "
Cubic feet of steam of atmospheric pressure furnished per minute, from bay water, with temperature of feed water 100° Fahr.,	2750·26
Pounds of coal burned per hour per square foot of heating surface,	0·595
" " " " grate surface,	15·352
Mean effective pressure on piston, per square inch,	23·1
Horses power developed by the engine,	207·8

During the above trip the heat in the lower part of the smoke chimney was sufficiently great to burn off the paint.

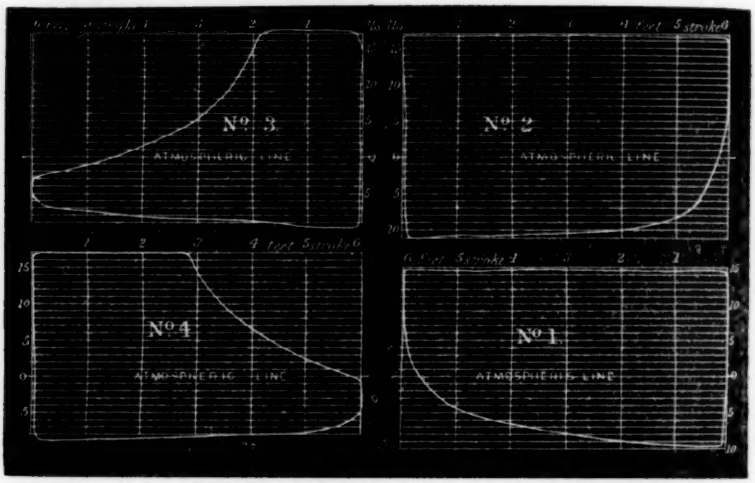
For the sake of ready comparison, I have collected the results of the foregoing trips into one table, an examination of which will show the effect produced by the various modifications of the boilers, and by the different drafts of vessel, immersion of paddles, &c.

Table of Results.

	Trial trip from Arsenal to Fort Washington and back.	Trip from Washington to Point Lookout.	Trip from Point Lookout to Baltimore.	Trip from Baltimore to Norfolk.
Speed of the vessel in statute miles per hour,	11·4545	8·73	6·978	10·556
Revolutions of the wheels per minute,	25	18·264	18·508	22·4
Slip of the centre of pres. of the paddles per cent,	24·63	21·38	37·98	22·48
Initial steam pres. in cyl. per sq. in. above atmo.,	18	11·3	22·3	18·3
Steam cut off at from commencement of stroke,	2 ft. 2 in.	3 ft. 8⅜ in.	3 ft. 6½ in.	3 ft. 7¼ in.
Consump. of Lackawanna anthracite per hour,	666	631	909	1090
Pounds of steam evaporated per hour, with temperature of feed water 100° Fahr. by one sq. foot of heating surface,	2·429	2·240	2·995	3·313
Pounds of steam evaporated per hour, with temperature of feed water 100° Fahr., by one pound of coal,	6·352	6·500	6·033	5·566
Cubic feet of steam of atmospheric pressure furnished per minute, with temperature of feed water 100° Fahr.,	1919·521	1859·222	2486·080	2750·26
Pounds of coal burned per hour per square foot of heating surface,	0·363	0·345	0·497	0·595
Pounds of coal burned per hour per square foot of grate surface,	10·918	10·344	14·902	15·352
Mean effective pressure on piston per sq. in.,	19·4	18·5	25·7	23·1
Horses power developed by the engine,	194·78	135·69	191·02	207·8
Mean draft of vessel,	7 ft. 3 in.	8 ft. 11 in.	8 ft. 10 in.	8 ft. 9 in.
Immersion of lower edge of paddles,	2 ft. 11 in.	4 ft. 7 in.	4 ft. 6 in.	4 ft. 5½ in.
Immersed amidship section in square feet,	136	174·3	172·4	170·5
Displacement in tons of 2240 pounds,	407·4	529·2	522·08	517·0
Condition of water,	Smooth.	Smooth.	Head sea.	Md. on qr.
Condition of wind,	Gentle breeze.	Light fair wind	Half gale ahead.	Mod. on qr.; no sail set.

From the foregoing results it will be perceived that these boilers only gave an average performance, and the reason must be looked for principally in the cross area of the flue, compared with its length and surface. The heated gases passed out before their temperature was sufficiently reduced, and they were not brought in contact with the heat absorbing surfaces for the proper length of time. The thickness of the flue iron was a scant quarter of an inch; that of the other heat absorbing surface, $\frac{3}{16}$ths of an inch. The flues were also too deep, probably 21 inches too deep, for the gases to diffuse over, and the main current of hot gas, and consequently, the principal heating portion of the flues, were to a great extent comprised between the dotted lines in the large engraving. The net cost of the boilers complete, was 13½ cents per pound.

By an examination of the table of results, it will be perceived that just in proportion as a greater amount of coal was burned, the evaporative result decreased. But the maximum amount burned per square foot of grate surface per hour, was only 15·352 pounds, with a proportion of heating to grate surface of 25·8 to 1·0, a proportion larger than sufficient to absorb the heat generated, had it been brought in contact with it; consequently, had all the heat absorbing surface been effective, the evaporation with anthracite would have been as high economically with the combustion of 1090 pounds, as with that of 631 pounds; but if the effective heat absorbing surface be considered greatly reduced, it is plain why the combustion of a less amount of coal in the same time should give a higher result.



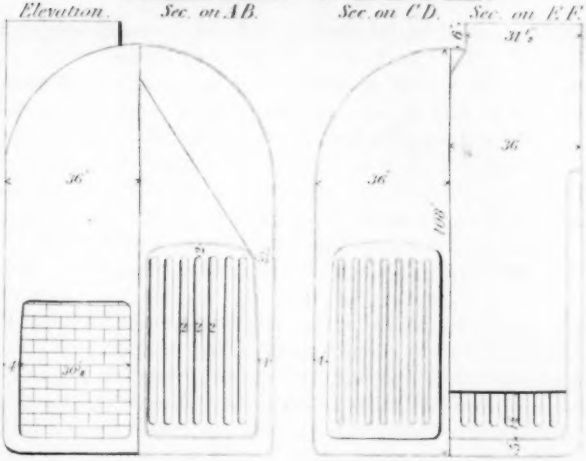
During the preceding trips, there was always a great amount of back pressure in the condenser, owing principally to the arrangement of the air pump, which was inclined, and had a solid piston. The engine never made what is called "a good vacuum." The indicator cards show the condition of the valves; Nos. 1 and 2 were taken in quick succession from the top and bottom of the cylinder, working full stroke at the Dock; revolutions of the wheels, 11 per minute. Nos. 3 and 4 were similarly taken during the trial trip, the cut-off remaining the same in both; revolutions of the wheels, 26 per minute.

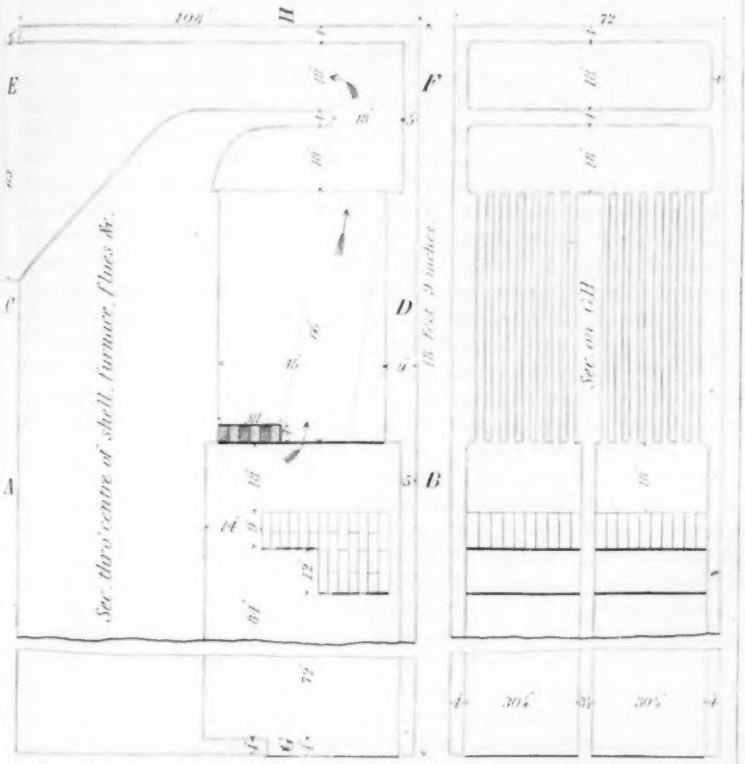
On the Arrangement of the Materials in the Blast Furnace, and the Application of the Waste Gases. By Mr. Samuel H. Blackwell.*

The use of the waste gases given off from the top of the blast furnace, has been long known and adopted in many of the Continental iron works. The higher cost of fuel, and the greater attention paid to a scientific knowledge of the most important process of manufacture, led to the use

* From the London Journal of Arts and Sciences, January 1853.

Boilers of U.S.S.
WATER WITCH.





of the waste gases of the blast furnace in the works of France and Germany, long before their application here. The United States soon followed the example of the Continent; and in the iron works of Pennsylvania, for some years past, the use of the waste gases has been general. The object of this paper is to point out some of the causes which have prevented their more general use in England in our great iron works, and to call attention to some light thrown, by the attempts to use them, upon the best arrangement of the materials in the furnace.

The first attempt to apply the gases in our iron works was made at Ystal-y-Fera, in South Wales, by Mr. Budd, who obtained a patent for their use.

The method of employing them was at first defective, from the direct flame of the furnace being taken off instead of the gases themselves. The moment the gases emerge from the top of the furnace, and unite with the atmosphere, ignition takes place; and if the flame is to be economized, it must be immediately applied to the surface upon which it is to act, or its heating power is given off and consequently wasted. The attempt therefore to apply flame, necessitated the erection of the boilers, or of the pipes in which the blast was to be heated, in immediate contiguity with the tunnel head. In many works this was a matter of great difficulty, and in very few could it be done without inconvenience. Even where practicable, the flame always acted powerfully upon the passages through which it passed, and exhausted itself, in proportion to their length and absorbing powers, before it became available at the points where it was really required. This difficulty led to such an alteration in the arrangements adopted, that instead of the flame, the gases themselves could be drawn off from the materials in the furnace, before they had become ignited by mixing with air. For this purpose a cylinder of cast or wrought iron, resting by a broad flanch upon the upper part of the lining of the furnace, was carried down into the interior of the furnace to a depth of several feet beneath the top of a horizontal pipe, through which the gases passed off. The diameter of the furnace expanding from the top downwards, an open space was thus enclosed between the inside wall of the furnace and the cylinder, forming a reservoir for the gas, into which as long as the cylinder was kept full, no air from above could enter.

This arrangement perfectly answered its purpose, as far as taking off the gases unignited; and although they still passed off at a high temperature, the loss of heat in the passages was much diminished, being confined to simple radiation from the hot but unignited gas: however far it was carried, its chemical nature remained unchanged, and atmospheric air was allowed to mix with it only on its reaching the point where the heat given off in its combustion became available. All difficulty in placing either the pipes for heating the blast or the boilers was thus obviated; but there remained two sources of inconvenience. First, a very powerful draft was required to be given by a sufficient height of stack to draw off the gases with regularity; and second, the entire quantity which it was possible to draw off, under the most favorable circumstances, bore only a small proportion to the entire quantity generated in the furnace—the greater part of which still escaped through the open cylinder.

Where a powerful stack was at hand, and where it was not a matter

of importance to economize the entire amount of gas generated, this arrangement was in many instances satisfactory. It was not, however, always so; in many works it was found impossible to get the furnaces to work well after the gases were taken off; great fretting of the tuyeres, accompanied by frequent scaffolding and slipping in the furnace, was constantly producing irregularity in its working;—the quantity made would thus be much decreased; and, after much annoyance, the attempt to use the gases was in such cases generally abandoned, as productive of more inconvenience and loss than economy. This was much more the case in South Staffordshire than in Wales. In the former district it led, after three or four trials, all with the same result, to its complete abandonment. It was difficult to understand the cause of this great irregularity in the results obtained, which at first seemed inexplicable; but this cause is now believed to be fully understood.

In the year 1849, two furnaces in Derbyshire were placed in the writer's hands, from which the gases were taken off for the purposes of heating the blast. The furnace worked with considerable regularity whenever the heat could be properly mantained, but this was not constantly the case, in consequence of the opening into the gas flues being situated so near the top of the furnace that, when the wind was in certain directions, the gas did not pass off with regularity, or if it came off in sufficient quantity, it was so mixed with atmospheric air that it burned down the passages, and thus occasioned great inconvenience. The writer determined upon obviating this by covering the opening into the gas flue with a wrought iron cylinder. The tops of the furnaces were small, and only admitted by cylinders of the respective sizes of 4½ feet and 6 feet being employed. This effect was perfectly satisfactory, in enabling a regular supply of unignited gas to be obtained; but the furnace with the 4½-feet cylinder began to scaffold and slip; the tuyeres were exceedingly troublesome; and the weekly make fell off considerably. After a trial of one or two weeks, the cylinder was taken out, other means were adopted to prevent the gas taken off from becoming ignited, and the furnace again resumed its former regularity. The furnace into which the 6-feet cylinder had been placed, worked far better, but not quite satisfactorily; and upon the cylinder burning out, it was not replaced,—arrangements being made similar to those adopted in the other furnace. It will not be necessary to describe these arrangements, as arrangements similar in principle, but improved by subsequent experience, will be afterwards described. Both furnaces have worked ever since satisfactorily, and the gases taken off furnish all the heat required for heating the blast,—no slack whatever having been used for some years for the purpose.

It was evident from this trial, and from similar results at other works, that the irregularity did not arise from the mere abstraction of the gases themselves; and there was only one other cause to which it could be attributed, viz: the narrowing of the filling part of the furnace; and the question then arose, in what way did this operate? The first suggestion that presented itself was naturally that the effect produced arose from decreasing the area through which the gases generated in the furnace were given

off, and thus causing greater obstruction to the free passage of the blast. The explanation was soon found to be untenable.

The saving effected in some of the Welsh works by the use of such portion of the gases as could be economized by the use of the cylinders employed there, led to a wish to make the entire quantity of gas generated available, by closing the top of the furnace, and not allowing any gas to escape into the open air. This was first effected by Mr. Levick, at the Cwm Celyn Works. In the arrangement adopted by him, two cast iron bearers extend horizontally across the furnace, at a depth of about seven feet below the top; and upon these a cone of cast iron is placed,—the base of the cone being less than the diameter of the furnace. A short cylinder about three feet and a half deep is suspended from the filling plate, resting by a flanch (as in the case of the cylinders previously described) upon the lining of the furnace; and a second cylinder of about the same depth rests upon the base of the cone. This second cylinder is larger than the first, and being movable around it, can be lifted by means of two bars of iron or chains, attached to it, and passing through openings made for the purpose in the flanch of the upper cylinder. The pipe for the passage of the gases extends horizontally from the upper part of the interior of the furnace. When the lower cylinder rests upon the cone, the top of the furnace is closed in entirely, and the space inside the two cylinders can be filled with the materials constituting the charge. Upon lifting the lower cylinder, the charge immediately falls into the furnace round the base of the cone; and the cylinder being again lowered, the top is once more closed in.

Another arrangement for effecting the same object, was soon afterwards adopted at the Ebbw Vale works. In this arrangement an inverted and truncated hollow cone is fixed in the top of the furnace,—resting on the lining by a flanch, similar to those employed to suspend the cylinders. The truncated end is closed by another cone, the apex of which ascends through it; and this closing cone is suspended by a chain, passing over a pulley, by which it can be lowered or raised at pleasure. On the lower cone being raised, the furnace is closed, and the materials wheeled into the upper cone; and when the movable cone is lowered again, the materials at once drop into the furnace. This arrangement is now in full operation, and working satisfactorily at several of the works belonging to the Ebbw Vale Company. Both at these works, and also at the Cwm Celyn Works, the furnaces with the closed tops work well; they carry equal, if not better burdens than those which are open; they work with equal regularity, and make an equal quantity of iron. The area through which the gases are taken off is in some cases not equal to that of a 3-feet pipe, and much less than that of the smallest of the cylinders which produced such unfavorable results. Consequently, the injurious action of these cylinders could not arise from the decreased vent permitted to the gases, nor to any obstruction in the blast. The only other way in which the cylinders could produce any effect would be by causing the materials filled into the furnace to fall too much towards the centre of the furnace,—thus producing an arrangement of them, which in some way acts prejudicially upon its general working. By the action of the cones, the materials wheeled into the closed furnaces are scattered round the side of the furnace, and are thus arranged as they would be in

open furnaces with wide tops. It thus became at once obvious that cylinders in Wales had been productive of less injurious consequences to the general working of the furnace than those in Staffordshire, because the greater width of the Welsh tops had permitted cylinders of from 8 to 10 feet to be employed, whilst in Staffordshire only cylinders of much less size were practicable.

The important effect produced on the working of the furnace, chiefly by an alteration in the arrangement of the materials in the furnace, is a point of considerable interest, but one to which little attention has been hitherto paid. In practice it has been long known to the best managers of furnaces, that wide tops were desirable, and generally accompanied by increased make; but the precise manner in which wide tops acted was not clearly known until the attempt to use the waste gases led to its evident explanation. On the Continent, the importance of such arrangement of materials as would facilitate the passage of the blast, as nearly towards the centre of the furnace as practicable, has been known for some time and acted upon; and the writer was much pleased to find from M. Tunner, Professor of Metallurgy, in Austria, and connected with the Styrian Iron Works, that great increase of make had followed the adoption of wide tops to the charcoal furnaces of that district, combined with a method of filling, by which the coke or charcoal was placed in the centre of the furnace, and the ore and limestone around the sides.

Some few months back a furnace was placed in the writer's hands, which he found provided with a cylinder and other arrangements for taking off the gases. Although apprehensive that the cylinder would materially interfere with the working of the furnace, yet, as everything was arranged for it, and as it was six feet in diameter, he determined to blow it in without alteration. This was done—the expected result following, —constant slipping, and fretting tuyeres, with all their attendant bad results. The stacks were not powerful enough to draw off the gases, unless a closed top was used; and the writer therefore adopted an arrangement somewhat similar to the Ebbw Vale one. The result was immediate; the furnace worked with great regularity, and carried a good burden; but white iron alone was produced. The burden was lightened, but the iron remained white. A farther lightening of the burden was made; but although the cinder was exceedingly gray, still the iron was white. It became evident that a greater proportion of coke would not produce the desired change, and was in fact useless. The white iron was evidently the effect of the closed top. A pipe of nine inches diameter was inserted at the filling place, but with no effect. Another pipe was inserted, and some little change appeared.

It being important to produce gray iron, it was now determined to sacrifice the use of the gases entirely, rather than continue to make white iron. A lid or valve upon the main gas-pipe, and a covering on the top of an auxiliary gas-pipe were now opened to the atmosphere, and a decided change was at once evident. The iron became gray and the furnace worked with regularity. The white iron had evidently been caused by the pressure produced by the closed top; and so extremely sensitive did the furnace appear to be to the slightest restraint, upon the free passage of the gases, that even a strong wind blowing into the open

box, through which the gases were principally escaping, would throw the furnace back to white iron.

In Wales, where the closed tops are successfully employed, the production of white iron is rather sought for, and hence the tendency in closed tops to produce that quality is no disadvantage. In many cases, however, it must be a fatal objection to their use. But for this objection closed tops would become universal; as they entirely do away with the necessity for a lofty stack, and enable all the gases to be economized. That the tendency to produce white iron has no connexion with the mere abstraction of the gases from the furnace is clearly shown by the results of the Scotch furnaces, in which they are taken off without employing closed tops. At Dundyvan, especially, great attention has been paid to this point; and the result has been shown to be that the furnaces from which the gases are taken, work with equal regularity, and produce gray iron with equal facility to those from which the gases are not taken; and it would be easy to multiply instances of the same result.

To be Continued.

For the Journal of the Franklin Institute.

On the Analysis of Cast Iron. By Professors Campbell Morfit and James C. Booth.

(Extract from the Official Report to Captain L. A. B. Walbach, U. S. Ordnance, on Foundry Service, upon the Examination of Gun Metal.)

The associated substances always occurring with the ores, in the furnace, are silica, lime, and alumina; in addition to which, sulphur, phosphoric acid, oxide of manganese, magnesia, and the alkalies are rarely absent. Substances of more unusual occurrence are oxides of chronium, tin, titanium, vanadium, copper, arsenic, and some others. Now, although most of these substances are reduced to their metallic state with great difficulty, by the fuel and high heat of the furnace, yet their affinity for oxygen is weakened, and the contact of a large quantity of metallic iron adds its influence to reduce portions of them to metal, in which state they enter into combination or admixture with the iron. Hence crude cast iron or pig iron, besides its essential constituent carbon, contains more or less of the elements of the ingredients above named, though always in small proportion to the iron, and, in their total amount, rarely exceeding eight to ten per cent.

The influence of these associates upon the character and influence of cast iron has been determined to a limited extent, and in the case of only a few of them. Thus, a considerable proportion of manganese is said to impart a large lamellar and brilliant fracture and some degree of brittleness; phosphorus is supposed to render iron "*cold short*," and sulphur, "*hot short*." But the full extent of influence of these few is yet undecided; while the influence of most others is either unknown or at least subject to great doubt.

Although most of the above are only occasional constituents, and exist, when present, only in minute quantities, still it was expedient that

the examination should be made with a view to the detection of each and every one of them.

Pulverization.—It was found, after repeated trials, that the only sure way of obtaining samples of uniform composition was to clip off pieces of the size of $\frac{1}{8}$th to $\frac{1}{10}$th of an inch diameter, by means of a cold chisel and hammer. These were taken from the small broken cylinders, which had been bored from the muzzle of the gun, and had served for the mechanical tests. Reduction under the pestle and sifting should be avoided; for any process, which requires that the metal shall be acted upon in a state of *powder*, is defective; because the slag and graphitic carbon being, as it were, mere mechanical components pervading the mass of iron and not chemically combined with it, form finer particles by pulverization, which from their low specific gravity fly off partly as dust. This loss and the difficulty of reducing the metallic granules to the same state of fineness as the siliciuretted and carburetted constituents of this metal, prevent the possibility of obtaining a mixture sufficiently uniform to afford a fair average sample. We found that equal portions of the same powder gave under the same circumstances variable results, whatever solvent was employed. Thus one gramme digested in nitro-muriatic acid, gave of insoluble residue, in two sets of experiments similarly conducted:—

Total Insoluble Residue.

	1.	2.
Sample, *a*,	·0456	·0486
b,	·0480	·0682
c,	·0436	·0568
d,	·0460	·0612

These were selected indiscriminately from more than twenty experiments, all of which yielded results that are equally conclusive. In several trials, the proportion of insoluble residue obtained from the samples of *dusty* metal, presented a greater variation than those from the clippings or even the fine granules. The discrepancy arises from the facts just mentioned. It is also because the mixed metal, in its finest state of comminution, is peculiarly sensitive to a decomposing or transforming action of the digesting liquids, which, instead of being confined solely to effecting solution of the metallic bases, extends to the transmutation of some of the other constituents into soluble matter, as will be treated in the paragraphs relating to the estimation of carbon, slag, and silicium. It is therefore imperative that, first, in reducing the metal mechanically, it must be to clippings, and not to powder. The size should be from $\frac{1}{8}$th to $\frac{1}{10}$th of an inch diameter, as this bulk is better adapted to insure a gradual reaction and uniformly exact results.

Total Amount of Carbon.—The important bearing of this ingredient upon the quality of cast iron renders its accurate estimation of paramount importance; for the metal is classified into *gray* and *white* varieties, according to the condition in which the carbon exists in it. For instance, in gray iron there is both combined and free (graphitic) carbon; while in the white the carbon is wholly or nearly all combined with the metal. Now, as the only way of accurately determining the former condition is by deducting the graphitic from the totality of carbon, it is essentially important, that these last two should be estimated with great precision. The

most usual method of determining the whole of the carbon is to ignite five grammes of the finely powdered metal, in a combustion tube, with a mixture of anhydrous chromate of lead and chlorate of potassa, or with oxide of copper. By the aid of high heat and the oxygen generated by the decomposition of those highly oxydizing bodies, the carbon burns off as carbonic acid, and is condensed by caustic potassa contained in a bulbed receiver. The increase of weight which the latter acquires by the process of combustion represents the amount of carbonic acid absorbed, whence the total amount of carbon is calculated. This plan, although expeditious, is liable to many objections; the chief of which is the necessity of having the metal in an impalpable powder, in order to effect its complete combustion. This entails the disadvantages enumerated in the paragraph upon PULVERIZATION. It will also be necessary, in most cases, to repeat the ignition in order to check doubtful results.

Another and very accurate method is that proposed by Berzelius, and which consists in depositing a weighed lump of five grammes of metal upon a fused cake of 30 to 40 grammes of chloride of silver, in a vessel containing water and closely covered to prevent access of air. A little hydrochloric acid is added to promote the action. The silver salt gradually decomposing, gives up its chlorine to the *bases* of the metallic iron, which by the union, become soluble in the water as chlorides, while the eliminated carbon, silicium, and slag subside to the bottom upon the silver cake, which is more or less reduced to the metallic state. The liquor being filtered off through a small paper, the undecomposed portion of chloride of silver is removed with a platinum pointed pincette, freed of adhering particles by means of the wash bottle, and reserved for use at another time. The contents of the filter, while still moist, are to be rinsed out into a beaker, treated with dilute nitric acid and gently warmed to dissolve the reduced silver powder and any traces of oxide of iron. Great care must be observed to provide against too much heat, so as to prevent portions of the carbon from being converted into soluble artificial tannin. When the whole of the silver and oxide of iron has been taken up, the liquor is filtered on a balanced filter, which is washed with hot water, dried first in a hot air chamber and finally in vacuo, and weighed. The gross amount of carbon, silica, and slag is thus obtained. By ignition the whole of the carbon is burned off, and the amount determined by weighing the calx. The difference between the two weights, which is the amount lost by the ignition, represents the carbon.

Solution of chloride of copper has been suggested as a substitute for the solid chloride of silver, and its action is more energetic and rapid; but the objection to the plan is, that a small portion of the carbon is lost as carbo-hydrogen gas.

The above plan has the advantage of giving the total carbon in one operation; but it is tedious, time consuming, and only manageable with difficulty. Ten to twenty days are necessary for the perfect completion of the operation; and if any air should accidentally enter the digesting vessel, the consequent formation of hydrated peroxide of iron is a serious impediment to the progress of the reaction. The traces of hydrochloric acid, with which the water may be acidulated, tend to prevent the generation of this oxide, but it must be used sparingly, since, otherwise,

by taking up some of the metalic iron, a part of the carbon might be driven off. Free chlorine has also been proposed by Berzelius, but its use is less practicable than the preceding method; because bulbed glass apparatus, requiring nice arrangement and careful management, must be employed by his mode. There is, moreover, difficulty in volatilizing all the chloride of iron formed, and also in preventing the access of air, which by its oxygen, will convert some of the carbon into carbonic acid or oxide, or both.

Another process by the same distinguished chemist consists in subjecting the iron in filings to the spontaneous action of dilute but perfectly pure nitric acid added portionwise. It is time consuming, and requires great attention to insure uniform reaction; for much heat is eliminated, and may raise the temperature of the mixture above 125° Fahr., and thus promote the transformation of a portion of the carbon into soluble matter, as mentioned in the paragraph relating to graphitic carbon. Moreover, a basic salt of iron, soluble with difficulty in cold acid, is likely to be formed. Besides, if any of the foreign alloys are convertible into insoluble oxides by the nitric acid, they remain with the carbon and silicium; and in the after-separation of the former from the latter, by ignition, they may by entire or partial volatilization with the carbon, lead to error in its estimation.

Berthier's process of estimating the total amount of carbon, by slowly oxidizing the iron by exposing it to the air and moisture, is tedious and tends to error, from the fact, that the hydrochloric acid required in the after part of the operation, to dissolve out oxide of iron, as well as the subsequent evaporation to dryness to render the silica, &c., insoluble, subjects the carbon to a partial conversion into soluble humus.

After repeated trials and due consideration of the above and other processes for estimating the total amount of carbon, we were convinced that none of them possessed that union of speed and accuracy which is necessary to a satisfactory performance of the analysis. We therefore abandoned them, and proceeded to a course of experiment, with the view of elaborating a process which would be rapid as well as reliable; and succeeded in developing the following method.

2d. One gramme of metal clippings, having been accurately weighed, is placed in a small beaker with the atomic proportion of iodine, say, 5 grammes of iodine to one of metal; a little water is added, and the glass with its cover on, left at rest in the cold. Five to six hours suffice for completing the solution of the bases; and the rapidity of action is inversely as the state of dilution of the liquid, so that only enough of water to cover the mixture should be employed. Perfect solution is recognised in the dark brown liquid by the flocculent character of the insoluble matter, as compared with the heavier and metallic particles; and if any of the latter still remain unacted upon, they will subside heavily to the bottom. In such case, a few more grains of iodine must be added, if the first portion has entirely dissolved, and the digestion arrested by filtration, as soon as the solution of the metal has been accomplished, for a prolonged action of the iodine, as well as too great dilution promote the oxidation and volatilization of the carbon.

Great care must be observed to temper the reaction, which, when violent,

gives off a distinct odor analogous to that of chloride of sulphur. *Slight* additions of water, therefore, become occasionally necessary, for undue warmth is apt to induce the conversion of a portion of the carbon into soluble matter. This reaction is particularly evident when the metal is in very fine powder. Water is probably decomposed, the oxygen going to the carbon and iron, and the hydrogen to the iodine, which then, in its compounded hydriodic acid form, unites with the oxide of iron.

For example, we present a few results, selected indiscriminately from many equally conclusive, which not only show the difference between the digestions with iodine at hot and cold temperatures, but also the inequality of the "hot carbon," results owing to the difficulty of so regulating the heat as to produce uniformity of reaction.

	Clippings digested with Iodine in the cold. Total Carbon.	*Powdered metal digested with Iodine on the sand bath.* Total Carbon.	
	1	1	2
No. *m*,	·046	·037	
No. *n*,	·039	·024	
No. *k*,	·038	·028	
No. *p*,	·045	·022	
No. *e*,	·042	·0085	·024
No. *f*,	·044	·034	
No. *s*,	·026	·016	
No. *h*,	·033	·029	·0285
No. *j*,	·039	·0255	·0380
No. *c*,	·034	·016	·0255

When it is evident that no fine particles of metal remain at the bottom of the beaker, the solution is perfect, and the insoluble matters, consisting of all of the carbon, slag, some silica, and a portion of oxide of iron, formed as mentioned under "slag and silicium," float in the liquid, which contains the bases or remaining constituents as iodides. The solution is to be immediately diluted with water, filtered through a balanced filter, washed with hot water, then with hydrochloric acid to remove traces of sesqui-oxide of iron, and finally with hot water. The filter is then first dried between the folds of bibulous paper, and subsequently in vacuo, along with the counterpoised paper. The two are then weighed against each other, and the difference of weight denotes the amount of insoluble residue. As this latter does not consist wholly of carbon, but also contains slag and some silex and perhaps alumina, the filter must be transferred to a platinum crucible, cautiously ignited over a lamp, and finally by the blast, until every particle of carbon is burned off, as may be known when the residual calx presents no black specks, and again weighed. The loss by ignition represents the total amount of carbon contained in the iron, and is to be determined by deducting the weight of the calx from the weight of the calx and carbon combined.

The filtrate is rejected, because of the large excess of iodine which it contains, as the evaporation to dryness with hydrochloric acid requisite for its expulsion, would so diminish the phosphoric acid as to render its estimation from such a solution inaccurate.

Allotropic or Graphitic Carbon.—We have already stated that the carbon in cast iron may exist in two conditions, combined and free; in the latter or free state it is usually termed graphitic carbon, from its identity with

native graphite or plumbago, possessing the same chemical composition, viz: being essentially pure carbon, and the same external character of scaly structure, color, greasy feel, and softness. Regarding the diamond as one form of pure carbon and graphite as another, they have been termed allotropic conditions of that element, and hence in speaking of the graphitic variety, we have termed it allotropic.

White cast iron contains all the carbon in a state of combination if it be rapidly cooled after fusion; but by slower cooling, a portion of the carbon is eliminated or precipitated through the mass, in the form of graphite, the black scales of which contrasting with the whiter color of the metal, give the appearance of *gray* iron. Where the precipitation takes place only in spots, the metal is termed *mottled*. This artificial graphite is equally resistant of chemical agents as the native plumbago, and since the combined carbon when separated from cast iron by chemical agency is easily acted upon, we availed ourselves of their different behavior to determine their relative quantities. In our first essays we followed the method of Karsten for estimating the allotropic carbon, because it had the sanction of high authority; but we found by experience that it is unsatisfactory. The process consists in dissolving a given weight of the powdered metal in nitric acid, by gentle heat, adding a little hydrochloric acid towards the end of the digestion, to ensure the solution of any undecomposed silicide, oxide, or phosphide not wholly soluble in single acids, and to prevent the formation of insoluble sub-nitrates, which are apt to be generated when nitric acid alone is used. After perfect solution, the whole is passed through a balanced filter, washed with hot caustic potassa solution to remove extractive matter, then with hot water and hydrochloric acid, and again with hot water. The filter, after being dried between paper and in vacuo, with its counterpoise, is weighed against the latter. The difference between the two expresses, quantitatively, the contents of the filter, which consist of carbon, slag, and some little perhaps of silica. They are separated by transferring the filter to a platinum crucible, igniting, and reweighing. The calx remains, but the carbon is burned off, and the loss in weight indicates its amount.

It is so very difficult to regulate the action of the nitric acid, that inequality of results is unavoidable. For example, carbon is variably sensitive to the action of nitric acid, according to its strength and the temperature. At the moment of elimination, it is in an impalpable state, which is peculiarly conducive to chemical action. Nor is this behavior confined solely to the combined carbon, for under the unavoidable circumstances of the digestion, the allotropic carbon is likewise altered, as is proved by the few following examples, selected from a series. Allotropic carbon is particularly changed by the *prolonged* digestion which is necessary to effect perfect solution, and if *fuming* nitric acid is added to facilitate the reaction, complexity of the change is augmented, and an irremediable source of error created. The annexed results not only lack uniformity in the two series, but also show in the first, a much less proportion of allotropic carbon than really exists in the iron, as is confirmed by the results of a correct process, given on the succeeding page.

	Allotropic Carbon.	
	First Essay.	Second Essay.
No. *a*,	·0106	·0294
No. *b*,	·0150	·0350
No. *c*,	·0156	·0350
No. *d*,	·0160	·0314
No. *e*,	·0210	·0085

Even slight differences in temperature and strength of acid induce important changes; and after some thirty experiments with results like the preceding, we abandoned Karsten's process as erroneous in principle and fact, and consequently discarded the results obtained by it. The essays to which this disappointment led were more propitious, and ended in a modification of Brownie's process, which fulfils every requirement.

3d. The allotropic carbon is to be estimated by digesting one gramme of clippings of metal at a gentle heat, with hydrochloric acid of specific gravity 1·1. In a few hours, the soluble ingredients of the metal will have dissolved, leaving the carbon in flakes or lumps, along with some silica floating or suspended in the liquor. The sediment is to be collected upon a counterpoised filter, washed with hot solution of potassa of specific gravity 1·29, to remove humus and extractive, then with dilute hydrochloric acid, and finally with hot water. The last washing must be thorough, because if any alkaline chloride is retained, being volatile, it will mostly pass off with the carbon during ignition, and thus cause error in the determination of the latter. The filter is then dried, first between folds of paper and subsequently in vacuo, with its counterpoise; and the two are afterwards weighed against each other, and the difference in weight noted. It will be observed on examination, that the carbon is in scales, and remarkably free from dusty particles. The filter and contents are now to be transferred to a platinum crucible, ignited cautiously over a "Russia lamp," and weighed. The loss by ignition expresses the amount of allotropic carbon contained in the samples, and may be ascertained by weighing the calx and deducting its weight from the original weight of the filter and contents.

There are certain requisite precautions to secure the accuracy of this process. Great care must be observed, in the ignition, to burn off all the graphite, so that not even a black speck may be visible in the calx. All draft must likewise be prevented, for particles of the calx may be accidentally blown off, and error thus occasioned, since the loss would be estimated as loss by ignition, and the amount of graphite thus erroneously augmented.

In the reaction with the acid, it is designed to restrict the agency of the hydrochloric acid, as to the carbons, solely to the conversion of that which is in a combined condition into gaseous carbo-hydrogens and humus, which is easily soluble in a solution of caustic potassa. We have, however, found that it is necessary to limit its strength, in order to effect this change without simultaneously altering the allotropic carbon. For example, if the density of the acid is too great and the temperature too high, the results will be variable and unsatisfactory, as is proved by the following experiments:

	Allotropic Carbon.	
	1. Strong Acid.	2. Strong Acid.
No. *m*,	·0159	·0170
No. *o*,	·0110	·0042
No. *q*,	·0152	·0095
No. *r*,	·0181	.0138
No. *s*,	·0055	·0130

It is evident, therefore, that strong acid and a high temperature not only cause the entire transformation of the combined, but induce a partial alteration of the allotropic carbon; so that the results will be constantly varying according to the varying circumstances, and to the prolongation of the digestion. On the other hand, the acid must not be too dilute, nor the temperature too low, else the converse of the above will happen; and owing to deficient action, a portion of the combined carbon, instead of having passed off in gaseous and soluble forms, will remain in fine powder with the allotropic carbon, to contaminate it and hinder its correct estimation. A little experience and care will insure a well conducted manipulation, and consequently correct results.

Combined Carbon.—4th, The combined carbon is determined after the estimation of the TOTAL CARBON and the ALLOTROPIC CARBON, separately, by deducting the weight of the latter from that of the former; the difference expresses the amount of the combined carbon. As this method by subtraction is the only available one, it is therefore imperative to have correct figures in order to obtain accurate results.

Silicium and Slag.—Having believed that the silicium and slag, either conjointly or separately, were important constituents as influencing the quality of cast iron, our experiments for separating and estimating them were numerous and varied. The silicium is a chemical component of the iron, while the slag is a mechanical ingredient pervading its mass like the allotropic carbon. This slag also contains silicium, but as silica, and in combination with earthy bases and oxide of iron; hence in separating the silicium of the metal, it is necessary to avoid decomposing the slag at the same time, and thus taking up, also, a portion of its silica or bases.

The silicium exists originally in combination with the metal as silicide of iron, and becomes oxidized into silica during digestion with acid, &c. The slag is an accidental ingredient. It is therefore important to determine quantitatively these two conditions; a task not without difficulty, owing to a certain similarity in the behavior of silex and of slag, respectively, to the reagents necessarily employed as solvents.

It is necessary to digest a new portion of clippings for the estimation of these components. The filtrate from the digestion with iodine for TOTAL CARBON, as well as from that with hydrochloric acid for ALLOTROPIC CARBON, will not answer, for the following reasons:

In the iodine digestion at cold temperatures, all the iron is taken up, but a portion of the alumina as phosphate, and probably the lime and magnesia are left with the untouched carbons, silica and slag, so that these would not be correctly represented by the weight of the insoluble residue. In numerous essays, repeated for verification, the quantity of the so called slag and silex was invariably larger than that obtained with nitric or hydrochloric acid. Moreover, as it is difficult to prevent access of air, a small quantity of a basic salt is formed, which is not entirely removed

by the hydrochloric acid used in the final digestion, but tends to unite with the silica during ignition, and form a silicate resembling slag, whereby the normal slag is contaminated. The aluminum, calcium, magnesium, and phosphorus are oxidized by the oxygen of the water in the presence of the iodine. The large amount of slag always obtained by the digestion with iodine, induced at first the belief that the oxide of iron associated with it was free, and had originally existed as such in the metal, and being an oxy-base, was not touched by the iodine, nor yet by the hydriodic acid formed, owing to a deficient quantity of the latter. This view was founded on the fact, that digestion in acids, especially the hydrochloric, which leaves no basic salt, always gave less slag.

Nor can the slag and silicium be estimated from the hydrochloric digestion for *allotropic* carbon, because the solution would in that case have to be evaporated to dryness before filtration, in order to render all the silica insoluble; a process which, by concentrating the acid and augmenting the temperature, might endanger the partial conversion of the carbon into soluble humus and extractive; besides, the strength of the acid for the gaseous transformation of the carbon would have to be necessarily so high, that it might decompose the slag. The only course is to take a new portion and treat it as follows.

5th, One gramme of clippings of metal having been accurately weighed, is to be placed in a wide mouth flask. A funnel and a drying tube filled with fused chloride of calcium are adapted to the flask by means of a tightly fitting cork, and an exit tube, drawn out to a fine opening at its extremity, is fitted in like manner to the farther end of the drying tube. Having made certain by actual examination of the tightness of the joints, chemically pure hydrochloric acid of specific gravity 1·06 is then poured into the flask through the funnel tube, and the flask slightly warmed to start the action; gases are soon generated, and after having passed over a sufficiently long time to expel all atmospheric air from the interior of the flask, a lighted taper is applied to the fine orifice of the exit tube, so as to ignite the issuing jet of arseniretted or mixed gas which is formed from the elements of the contents of the flask. The burning jet is projected against a piece of cold white porcelain. If after five minutes of uninterrupted combustion there is no adhesive tache formed upon the porcelain, it is evident that there is no arsenic, since this process detects less than $\frac{1}{300}$th part of a grain of that metal, with certainty.

Great care must be observed with regard to the character of the tache, for phosphuretted and antimoniuretted hydrogen gases both give dark stains in a similar reaction; if it is not adhesive, no attention need be given to it, as it is merely a distillate of oily carbo-hydrogens or phosphorus sublimate. Moreover, if it is a long time in being generated, it may be estimated as a trace; but if it is large and distinct and prompt in appearing, then it must be quantitatively determined from the same sample as the sulphur, as hereinafter directed. This precaution about the tache is particularly necessary also for the reason that the odor of the phosphuretted hydrogen, as eliminated when iron is dissolved in hydrochloric acid, so nearly resembles that of the corresponding arsenic gas, as to be mistaken frequently for it. In the reaction the water is decomposed, its oxygen goes to the iron, which then unites with the acid; while its hydrogen in the nascent state joins with the eliminated arsenic, antimony, and phos-

phorus, and passes over in a gaseous inflammable state. The qualitative test for arsenic, at this stage of the process, is a convenient saving of the time and trouble of a separate digestion, and is no hindrance; for when the test is completed, the apparatus is to be taken apart, and the flask, covered with a watch glass, transferred to the ledge of the sand bath, and there left until the residue becomes flotant. Solution is then complete, and the liquid must be evaporated to dryness, redigested in very dilute hydrochloric acid, filtered, washed with hot water and hydrochloric acid, and lastly with hot water. After drying the filter, it is ignited in a platinum crucible over a "Russia" lamp to burn off carbon, and then weighed to ascertain the amount of residual calx which consists of silex and slag.

Care must be observed not to use acid stronger than specific gravity 1·06, or the slag will be attacked and its bases dissolved; nor must it be weaker, as it will cause loss of time in the digestion.

The insoluble portion on the filter must be invariably washed with hydrochloric acid, to remove any traces of iron or oxide that may remain accidentally, and which would afterwards add undue weight to the slag, for it is not removable by subsequent boiling with potassa solution.

Having obtained the silica and slag together, and accurately noted their united weight, they are transferred from the platinum crucible to a small silver capsule, and boiled for two minutes with a half fluid ounce of caustic potassa solution of 1·10, (specific gravity, 1·25, diluted with two volumes of water.) After sufficient repose for the subsidence of all suspended particles, which from their extreme fineness would otherwise pass through the paper, it is filtered on the finest paper, and washed with hot water until the filtrate leaves no stain when heated to dryness on a platinum spatula. Silica is dissolved, and the slag remains untouched.

Ley of greater density than above prescribed would decompose the slag by abstracting its silica, while a lesser strength would not take up all the free silica. Nor is carbonate of soda, even in dense solution, a good substitute, for although it may imperfectly dissolve silica while boiling, it cannot retain it on cooling, but drops it partly in a free state and partly as soluble silicate of soda. The strength before directed has been found by experiment to answer best; it takes up the silica while hot and retains it on cooling, but does not attack the slag.

After the filter has been washed and dried, it is ignited in a platinum crucible and weighed; the weight expresses the amount of slag, and this deducted from that of the silica and slag united, gives the proportion of soluble silica; whence its content of silicium is to be calculated.

To be Continued.

For the Journal of the Franklin Institute.

Models for Steamships—A Comparison of the Performance of the U. S. Steamships Susquehanna and Powhatan.

In the science of ship building, as at present understood, a variety of opinions exist respecting the proper form to be given to vessels propelled at high speeds by internal power, so as to combine the requisite displacement and stability with a minimum resistance. Of these conflicting

theories, two of the principal and most opposed to each other, refer to the position in the length of a vessel, of the "dead flat" or amidship section, involving also that of the centre of displacement. According to one party, this centre of displacement and fullest lines should be forward, and the finest lines of the ship abaft, so as to give every facility for the easy return of the disturbed liquid to its original position, after the vessel has passed through it. By the other theory, the finest lines should be those which divide the water forward, and the centre of displacement, therefore, be abaft the centre of length. Without pretending to discuss or argue a question of such importance, we shall submit certain facts bearing upon it, which being well authenticated are worth more in forming a correct judgment, than all the unsupported opinions which have been or can be advanced upon the subject.

The United States steamers *Susquehanna* and *Powhatan* are vessels of the same dimensions of length, breadth, and beam, intended to carry the same weights, sparred precisely alike, and provided with engines and wheels of the same size and description; the only difference (of any importance) between them consisting in their models.

In former numbers of this Journal, (Vide vol. xxiv, p. 251–6; vol. xxv, 127–36,) Mr. Isherwood, Chief Eng. U. S Navy, has furnished very correct and reliable data, respecting the peculiarities and performance of each vessel; the latter being the result of several hundred hours steaming at sea, carefully tabulated from the engineer's logs. It appears from these statements that the models of the two ships present, respectively, great approximation to the forms above alluded to, as advocated by the opposing parties in ship building. The *Susquehannna* being fullest forward, but with generally sharper lines below water, (requiring increased draft to obtain the same displacement,) in the most approved "old school" style. The *Powhatan*, on the contrary, having her bow and stern lines alike, and therefore not going quite so far in the innovations advocated by the "new school." Although the difference between the two is, therefore, not that of extremes, it is quite enough to produce a marked effect upon results.

A mean of 947 hours' steaming, without assistance from sails, and in average weather at sea, for the *Susquehanna;* and of 221 hours' steaming under the same circumstances for the *Powhatan*, present the following results:

	Susquehanna.	*Powhatan.*
Speed in knots,	7·433	9·679
Revolutions per minute,	10·259	12·627
Slip in per cents,	19·73	16·45
Pressure in boilers,	8·6	10·4
Average cut-off,	5 ft.	4 ft. 8 in.
Proportion of throttle open,	·375	·292
Back pressure in condenser,	2·	2·
Draft of water,	18 ft. 3¼	18 ft. 1 in.
Dip of paddles,	5 ft. 3¼	5 ft. 0 in.
Displacement at that draft,	3487·9	3489·6

By a fortunate coincidence (for a comparison) it will be seen that the displacement is precisely the same in both cases; therefore, *practically* speaking, the resistance to be propelled was the same, although we shall see that the *actual* resistance and therefore power required, differed materially.

The effective diameter of paddle wheel differs slightly, owing to the boards not being of the same width.

For the *Susquehanna* the effective diameter is 29·10 feet.
" *Powhatan* " " " 29·56 "

The loss from oblique action of paddles was in the former $19\frac{3}{10}$ per cent.; in the latter $18\frac{8}{10}$ per cent.

Now calling A = collective cylinder area, (sq. in.)
L = length of stroke, (in feet.)
P = mean effective pressure on piston during whole stroke.
sin. $^2\delta$ = difference between unity and the per centage lost by oblique action.
D = effective diameter of wheel, (in feet.)
R = revolutions per minute.
S = per centage of slip.
C = coefficient of vessel's resistance.

The pressure exerted by the engine is 2 A P; and in a horizontal direction, 2 A P sin.$^2\delta$.

The pressure of the resistance is $C \times V^2 = C \times \left(\frac{R\,(1-s)\,3{\cdot}1415\,D}{60}\right)^2$

The ratio between the velocity of the resistance and that of the power is, 3·1415 D, to 2 L.

Then $2\,A\,L\,P \sin.^2\delta = C\,(\cdot0086\,D^3\,R^2(1-s)^2)$

$$\text{or } C = \frac{A\,L\,P \sin.^2\delta}{\cdot0043\,D^3\,R^2\,(1-s)^2};$$

The mean effective pressure, deducting 2 pounds less cylinder than boiler pressure, 2 pounds back pressure, 1·5 pounds for working engine, and 5 per cent. in the remainder for friction of load, would be in the *Susquehanna*, $\frac{95}{100}((6{\cdot}6+14{\cdot}7)\cdot85-(2+1{\cdot}5)) = P = 13{\cdot}87$, and for the *Powhatan* in like manner, P = 14·57, whence we have for the coefficient of resistance as follows:

$$\textit{Susquehanna}\ C = \frac{7696\times10\times13{\cdot}87\times(1-{\cdot}193)}{\cdot0043\times24642\times105{\cdot}24\times{\cdot}645} = 119{\cdot}75;$$

$$\textit{Powhatan}\quad C = \frac{7696\times10\times14{\cdot}57\times(1-{\cdot}188)}{\cdot0043\times25829\times159{\cdot}24\times{\cdot}697} = 73{\cdot}88.$$

It therefore appears that the power required to drive these two vessels respectively at the same speed, with the same displacement, and under the same circumstances precisely, is really as $119\frac{3}{4}$ to $73\frac{7}{8}$, or as 1·621 to 1·000; or that with the same consumption of fuel, supposing steam to be cut off at the same point in both, their respective speeds must be as $\sqrt[3]{1{\cdot}621}$ to $\sqrt[3]{1{\cdot}000}$ or 1·175 to 1·000. By analyzing the causes of the great superiority in the *Powhatan's* model, it will be found traceable to two circumstances only; one is the reduced midship section at the same displacement, being but 644·25 instead of 673·65 square feet, owing to her having fuller lines below water than the *Susquehanna;* and the other, the position of the centre of displacement, which is 4 feet farther aft than in the *Susquehanna*, giving a cleaner and more easy entrance.

From the same log it will be observed that the consumption of fuel

was in the *Susquehanna* 3279, and in the *Powhatan* 3951 lbs. per hour. Had steam been cut off in the engines of the latter at 5 feet, instead of 4 feet 8 inches, her consumption would have been increased to 4228 pounds per hour, doing the same work, while the speeds were respectively, 7·433 and 9·679; the resistances, therefore, with the same model, should have been as $(7{\cdot}433)^3$ to $(9{\cdot}679)^3$, or as 410 : 907, or as 1 : 2·212, while the relative consumptions were 3279 to 4228 :: 1·00 : 1·290, hence, $(1{\cdot}00 \div 1{\cdot}00) : (2{\cdot}212 \div 1{\cdot}290)$ :: 1 : 1·714 for the ratio of resistances in the two vessels, instead of 1 : 1·621, as before obtained; showing that from some cause, the evaporative effect per pound of fuel was better in the *Powhatan*, in the ratio of 1·621 : 1·714 :: 1·00 : 1·057.

M.

For the Journal of the Franklin Institute.

Steamers Andes and Alps.

Hulls built by Wm. Denny & Sons; Engines by Tulloch & Denny, Dumbarton, Scotland, for the British and North American Royal Mail Line, (Cunard,) to run between New York and Liverpool.

Length on deck,	236 feet 6 inches.
Breadth of beam—*at midship section above the main wales*,	34 " 1 "
Depth of hold,	24 "
Draft of water at load line,	16 " 9 "
Capacity of coal bunkers,	400 tons.
Length of engine and boiler space,	76 "
Tonnage,	1807 "
Weight of engine,	336000 lbs.
Weight of boilers, with water,	336000 "
Total weight,	300 tons
Frames, shape and dimensions, double angle iron,	⌞ $5\frac{1}{2} \times \frac{3}{8} \times 3$
Frames, distance apart at centre,	15 inches.
Keel, dimensions,	9×3
Plates, thickness,	$\frac{7}{8}$ to $\frac{1}{2}$ inch.
Keelsons, number and dimensions,	2, same as frames.
Masts and rig,	Barque.
ENGINES.—Two vertical beam.	
Diameter of cylinders,	5 feet 6 inches.
Length of stroke,	4 " 6 "
Maximum revolutions per minute,	25
Geared 1 to $2\frac{1}{2}$ of propeller.	
PROPELLER.—True screw.	
Diameter,	14 "
Pitch,	18 "
Number of blades,	2
BOILERS.—Two tubular,	
Length,	15 feet 6 inches.
Breadth,	9 " 6 "
Height, *exclusive of steam chimney*,	14 "
Number of furnaces,	12
Length of grate bars,	6 " 9 "
Number of flues or tubes,	832
Internal diameter, of "	$3\frac{1}{4}$ "
Length of "	6 " 6 "
Diameter of smoke pipe,	5 " 11 "
Height of " "	40 "
Maximum Pressure of steam,	10 lbs.
Consumption of coal per hour,	2000 lbs.
Description of coal,	Bituminous.

Remarks.—Rivets $\frac{3}{4}$-inch in diameter, and $3\frac{1}{2}$ inches apart; plates double riveted and abutted at ends; strakes clincher laid. C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Steamers Building or just Finished in the United States.

New York.—Steamer (not yet named) for U. S. Mail Steamship Co., to ply between New York and Aspinwall. Hull by Wm. H. Webb. Machinery by Morgan Works.

HULL.—		
Length on deck,	275	feet.
Breadth of beam,	40	"
Depth of lower hold,	24	"
Depth below spar deck,	31	" 6 ins.
Draft loaded (expected,)	13	"
Tonnage,	2114	
ENGINE.—One inclined direct action.		
Diameter of cylinder,	65	inches.
Length of stroke,	10	feet.
Average revolutions, (expected,)	16	
BOILERS.—Two "drop flue," with one row of upper return flues.		
Length,	24	feet.
Breadth,	16	"
Height, except steam drum,	14	" 2 ins.
Number of furnaces,	8	
Breadth "	3	" 7 ins.
Length "	8	" 3 "
Grate surface,	228·25	sq. feet.
Total heating surface,		
Steam pressure,	15	pounds.
WHEELS.—		
Diameter over boards,	34	feet.
Length of "	8	"
Depth of "	1	" 4 ins.
Number of "	28	

Remarks.—Frames of ship, 18 inches deep, and sided 16 inches; distance apart, (centre to centre,) 32 inches; double diagonal iron straps, $5 \times \frac{3}{4}$ inches; floor filled in solid.

On a new Plastic Material for forming various Objects. *By* Prof. PURKINJE.*

Five parts of sifted whiting are mixed with a solution of 1 part of glue. When the whiting is worked up into a paste with the glue, a proportionate quantity of Venetian turpentine is added to it, by which the brittleness of the paste is destroyed. In order to prevent its clinging to the hands whilst the Venetian turpentine is being worked into the paste, a small quantity of linseed oil is added from time to time. The mass may also be colored by kneading in any color that may be desired. It may be pressed into shapes, and used for the production of *bas-reliefs* and other figures, such as animals, &c. It may also be worked by hand into models, during which operation the hands must be rubbed with linseed oil; the mass must also be kept warm during the process. When it cools and dries, which takes place in a few hours, it becomes as hard as stone, and may then be employed for the multiplication of these forms.—*Gewerbebl. aus Wurtemb.*, 1852, p. 45.

*From the London Chemical Gazette, No. 233.

For the Journal of the Franklin Institute.

Statistics of the Philadelphia Gas Works.

From the "Eighteenth Annual Report of the Trustees of the Philadelphia Gas Works," including also the Report of the Engineer, John C. Cresson, Esq., we quote the following facts:

The total amount of gas made at the works for the year ending December 31st, 1852, was 216,216,000 cubic feet.			
Of which there were delivered to private consumers,		169,268,000	cubic feet.
Public lights, ...		38,306,250	"
Used in works, offices, coal stores, and leakage,		8,641,750	"
		216,216,000	"
To produce this gas, there were used—			
Coal in the retorts, ...		680,792	bushels.
Coke used under the retorts, .	450,832		
Coke used in the yard and works, .	13,500		
		464,332	"
Lime for purifying, ...		49,149	"
And the surplus of coke made in the retorts after deducting that used to produce the gas, was .		404,680	"
It will therefore be seen that one bushel of coal made,			
Of Gas, . .	316·13	cub. ft.	
Of Coke, . . .	1·26	bushels,	
and that one bushel of lime purified 4400 cubic feet of gas.			
The total length of street mains now laid (in the city proper,) is, 604,166 feet, or 114·44 miles, of sizes varying from 2 to 20 inches in diameter.			
The number of private lights supplied, was—			
In the City proper, . . .	157,170		
In the Districts, . . .	9,085		
		166,255	
Of public lamps supplied in the City, .	1,818		
" " " Districts, .	308		
		2,126	

The Philadelphia Gas Works is the largest, and was one of the first establishments of the kind in the United States; and the price of gas is lower than from any other works in the Union, being but $1·90 per thousand to customers making prompt payment. Its growth has been so rapid as to render necessary a removal of the manufacturing department, owing to want of space in its present position. The gasometers, however, will remain at the old place; they are eleven in number, and of the following sizes; eight single, 50 feet diameter, 20 feet high; two telescopic, 80 feet by 40 feet; and one telescopic, 140 feet diameter, and 70 feet high, which last is still the largest in the world. At the new works the trustees are erecting a grand distributor, 160 feet diameter by 96 feet, telescopic, which will hold nearly two millions cubic feet. The average daily consumption during the past year has been about 600,000; the maximum consumption for 24 hours was 1,123,000 cubic feet.

Drawings and descriptions of the two large gas-holders and framings are now in course of preparation, and will be published in this Journal when completed.

For the Journal of the Franklin Institute.

What became of John Fitch?

As it is to this day an unsettled point, what city of the East had the glory of being the birth-place of Homer, so it has been equally undetermined as to the place in the great West where the mortal remains of one greater than Homer, have their resting place; I mean the great embodied *Genius of Steam;* the indigent, friendless machinist, John Fitch; the co-worker and adviser of Rumsay and Fulton. My object, however, is not to write an eulogy, much less a biography of the immortal Fitch, but simply to indicate the precise place of his interment. The writer of this having occasion, some twenty-five years ago, to bury a little nephew at Bardstown, in Nelson county, Kentucky, and having discovered in the crowded little protestant grave yard near the county jail, an open space 20 or 30 feet square, not occupied by graves, commenced digging his nephew's grave there, when he was stopped by the aged Sexton, Mr. Alex. McKeown, who said that spot "contained the bones of John Fitch, the great steam man;" that "the space was left thus large to build a monument to his memory by the State of Kentucky."

Hon. Ben Hardin and Dr. Burr Harrison, of whom inquiry was made, corroborated the statement of Mr. McKeown, the sexton, and stated that a resolution to erect a monument over Fitch had passed the Legislature of Kentucky, of which they had been members, but that no appropriation had ever been made to carry the resolution into effect. The aged sexton must long since have passed from earth, and it is probable there are now few, even in Bardstown, who could point out the grave of John Fitch.

ALEXANDER M. McDOWELL.

Demopolis, Ala., July 6th, 1852.

On the Decomposition of Ammonia by Heat, and the employment of the Gaseous Mixture thus produced in Analysis. *By* M. BOUET BONFIL.*

The author has found that ammoniacal gas, when passed through tubes filled with quicklime, is resolved into its elements, nitrogen and hydrogen, at a heat far below redness. In empty porcelain tubes, or in tubes filled with fragments of porcelain, the decomposition is imperfect. The author proposes to employ the mixed gases obtained by this mode of decomposition to the reduction of metallic oxides, where the nitrogen can do no harm. It is easy in this way to obtain hydrogen gas perfectly free from arsenic, antimony, carbon, &c.—*Comptes Rendus*, xxxiv. p. 588.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, February 17, 1853.

Samuel V. Merrick, President, in the chair.
John F. Frazer, Treasurer.
Isaac B. Garrigues, Recording Secretary.
The minutes of the last meeting were read and approved.
Donations to the Library were received from The Royal Institution, and

* From the London Chemical Gazette, No. 233.

The Royal Astronomical Society, London; L. Lea, Esq., U. S. Commissioner of Indian Affairs, City of Washington, D. C.; T. H. Forsyth, Esq., G. H. Hart, Esq., and J. C. Bryant, Esq., Pennsylvania Legislature; Dr. H. Hartshorne, P. A. Nicholson, T. Wadskier, the Philadelphia Gas Works, and the Mine Hill and Schuylkill Haven Railroad Company, Philadelphia.

Donations to the Cabinets from Dr. Isaac Smith, Dutchess county, N. York; A. P. Wattson, Esq., and Thomas Fisher, Esq., Philadelphia.

The Periodicals received in exchange for the Journal of the Institute were laid on the table.

The Treasurer read his statement of the receipts and payments for the month of January.

The Board of Managers and Standing Committees reported their minutes.

The Special Committees reported progress.

New candidates for membership in the Institute (6) were proposed, and the candidates (6) proposed at the last meeting were duly elected.

The Standing Committees for the ensuing year were nominated by the President, and appointed as follows:

On the Library.

John Allen,
James H. Cresson,
Samuel Capp,
George Erety,
Raper Hoskins,
J. Herman Hoeckly,
Amos Lukens,
William A. Rolin,
Clement W. Smith,
Thomas S. Stewart.

On Cabinet of Models.

Samuel S. Ash,
Harman Baugh,
William W. Babbett,
Washington Jones,
Israel W. Morris, Jr.,
Henry Newsham,
F. De B. Richards,
Charles J. Shain,
John A. Wimer,
Charles Welsh.

On Exhibitions.

John E. Addicks,
John Agnew,
H. P. M. Birkinbine,
John C. Cresson,
George W. Conarroe,
Owen Evans,
William Forsyth,
Algernon S. Roberts,
Alan Wood,
Thomas J. Weygandt.

Cabinet of Minerals and Geological Specimens.

John F. Frazer,
Wm. W. Fleming,
Angus N. Macpherson,
John S. Powell,
Dr. B. Howard Rand,
Percival Roberts,
Thomas F. Seal,
Dr. L. Turnbull,
Dr. C. M. Wetherill.

On Meetings.

Dr. Charles M. Cresson,
Stephen Colwell,
George W. Dewey,
Daniel Leeds,
J. Vaughan Merrick,
Dr. B. Howard Rand,
George W. Smith,
Charles E. Smith,
Dr. L. Turnbull,
Dr. C. M. Wetherill,

Cabinet of Arts and Manufactures.

James C. Booth,
Joseph J. Barras,
Samuel M. Bines,
George M. Conarroe,
William Harris,
William B. Smith,
J. McA. Sommerville,
Thomas J. Weygandt,
Isaac S. Williams,
Lewis E. Wells.

On Meteorology.

Dr. Martin H. Boyé,
Dr. Charles M. Cresson,
Owen Evans,
John F. Frazer,
L. C. Francis,
James A. Kirkpatrick,
Dr. James A. Meigs,
Dr. George R. Morehouse,
Dr. James V. Patterson,
Dr. George J. Ziegler.

Dr. Rand called the attention of the members to a Colt's revolver, (No. 1140,) which had nine balls jammed immovably in its barrel, and illustrated in a remarkable degree, the strength of the cast steel revolving

chamber. It was sent to him by Dr. Casper P. Lukens, of Illinois, from whom he had the following account of the circumstances:

The revolver had been in his possession more than three years, and has been fired over one thousand times without getting in the least out of order; in accuracy it was nearly equal to a duelling pistol. On the day previous to the accident, he had fired it seventy-five times. On the succeeding day he set his target upon a board, nearly the size of a window shutter, distance seven paces. The first ball put into the chamber was one that had been previously used, and was covered by a patch; the other balls used were too large for the chambers, and had to be forced down with an iron rod and hammer, leaving a ruff of lead around the bore; aim was taken, the pistol fired, no balls struck the board, the pistol making a louder report each time. It was again loaded, and four out of the five chambers discharged without any effect upon the board; the cock was driven back, the pistol almost driven out of the hand, and at the fourth discharge the bolt of the hammer was broken. On examining the barrel, it was found filled to within about two and a half inches of the muzzle with lead, and the last ball was found flattened against the lead at the breech of the barrel, a hemisphere of the ball fitting into the chamber. As the pistol could still be cocked, he fired another load of powder, but as may be supposed, without moving the mass of lead.

The powder used was of good quality, having on the previous day carried a ball 250 yards over still water with an elevation of 6 inches, and perforated an inch pine board at thirty paces; about twelve grains were used as a charge. The caps were Colt's regular army. It was found impossible to drive out the lead by a rod and hammer.

As exhibited, the pistol presented in its barrel about two-thirds full of lead, having a flattened ball, with its rounded portion fitting into the chamber. Except the broken pin mentioned, it was not damaged. Dr. Rand remarked that the windage between the chamber and the barrel was considerable, admitting readily a sheet of ordinary paper. Much of the expansive force of the powder might have found vent there, in the eight first discharges; but at the ninth the chamber was effectually closed by the hemisphere of the ball projecting into it, and jammed against the mass of lead, filling the barrel, so that the only vent for the explosive force was at the nipple, which was of ordinary size.

Dr. Rand also presented an exceedingly neat and portable hygrometer made by Mr. Thomas J. Weygandt. It is composed of a wooden helix; the inner portion of which is pine, cut across the grain; the outer, mahogany, cut in the direction of the grain. One extremity is fixed, the other connected with an index traversing a graduated dial. The unequ expansion of the outer and inner portions of the helix by moisture, causes a change in its form, which is indicated on the dial. The instrument, which is quite sensitive, is enclosed in a neat case of less than six inches cube.

Mr. Joseph Harrison exhibited to the meeting two iron cases, which had been made the subject of experiment, in determining the strength of stayed plates. The largest plate, 28 inches square, rim $\frac{3}{8}$-th inch thick, stays, $6\frac{1}{2}$ inches apart; $\frac{7}{8}$-inch diameter outside of the thread. It was proved at 900 pounds hydraulic pressure to the square inch, at which pressure no effect was produced. The smaller, 18 inches square; rim,

$\frac{1}{8}$-th inch thick, stays $\frac{1}{2}$-inch diameter outside of the thread, and $2\frac{3}{4}$-inches apart; proved at 295 lbs. pressure. This exhibited very marked appearance of bulging between the stays. The experiments were made at the works of Messrs. Harrison, Winans & Eastwick, at St. Petersburg, in 1848.

Mr. Harrison also exhibited a piece of leaden gas pipe eaten by rats. This piece of lead pipe formed part of a connexion for conveying gas from the basement to the first floor of a house he occupied in Liverpool, England, in 1850. The pipe passed through the ceiling of the basement story, and through the floor of the room above. Three several times the pipe was eaten through in the parts that passed between the ceiling and the floor. It was prevented from occurring again by putting in a piece of copper pipe, long enough to reach through the ceiling and floor.

The President remarked that when he was making the researches upon gas lighting in London, he found this occurrence so frequent as to cause him to recommend that the use of lead gas pipes be prohibited in this city, and iron substituted.

Mr. Harrison also submitted for the inspection of the members an exact model, reduced, of the great bell of Moscow. The original bell is 21 feet in diameter, and 21 feet high. The metal at the thickest part, 22 inches. It is estimated variously, to weigh from 400,000 to 444,000 pounds. It was cast in 1733. Also, specimens of the platina coins formerly in circulation in the empire of Russia. The specimens exhibited were of the respective values of $9·00, $4·50, and $2·25.

Mr. Enoch Woolmann, of Stark county, Ohio, exhibited a model of a plan for opening and shutting farm gates when riding or driving.

This gate is constructed by applying bevel cog work to the heel stile of the gate. The vertical cog piece has a lever, to which is attached a cord; this cord passes over pullies, and is suspended over the centre of the passage at a convenient distance from the gate, so that the driver can without raising from the seat, grasp it and pull the gate open, by pulling on the cord until the gate is entirely opened; it is fastened open, and all that is necessary in order to close it, is to give the cord on the opposite side a slight jerk, and the gate immediately closes and fastens by means of a weight.

Dr. Turnbull brought before the meeting a sample of compressed or solidified milk, manufactured at Dutchess County, New York, by Blatchford & Co., and sent to the Institute by Dr. Isaac Smith. It was in the form of square cakes of a compact crystalline character, yellowish white color, and sweet taste, resembling sweetened boiled milk. The following are the properties which it possesses, as stated in the letter from Dr. Smith. "It keeps well in any climate, and can be readily restored to the consistency of milk by adding one pound of it grated to two quarts of warm water. So little is it injured by the solidification that a good cream will rise on the solution after standing a few hours, and it readily coagulates when rennet is added to it."

The experiments made with it by Dr. Turnbull were not as satisfactory as those stated in the letter; for when warm water was added to the powdered material, there was not formed a perfect emulsion; numerous oily globules remained upon its surface.

With a solution of rennet in wine, it coagulated; on standing over night it formed a covering of white pellicles of an albuminous substance, like

the covering on milk after having been boiled; but it had not the true taste of cream, the liquid under it being sweet forming no lactic acid.

Dr. Turnbull had no doubt, however, that on a long voyage it would prove a good substitute for milk, although not as perfect as it might be made or as it is now made in France. He stated that the French method of preserving milk for long voyages was the following: pure fresh milk is mixed with well clarified raw sugar, in the proportion of four ounces to the gallon, and evaporated in open pans, fixed on steam boxes and connected with hollow steam pipes, kept at a temperature varying from 176° to 194° Fahr. During the whole of the time, agitators are caused to move round slowly in the milk by turning a handle; as the milk approaches the solid state, it is taken out of the pans and pressed in moulds into cakes of any suitable shape.

Mr. Frazer exhibited a rule, upon which were laid down equivalent portions of the various European measures. By means of a straight-edge moving over the scale, the expression of any one measure in divisions of another was readily obtained.

Mr. F. O. Deschamps exhibited and explained his passenger register for omnibuses. This instrument is placed in the front panel of the omnibus, and resembles in appearance, a clock face numbered up to 36, with a single index.

It is the duty of the driver, upon the receipt of each fare, to pull a handle, which rings a bell inside the instrument, and at the same time causes the index to move forward one division upon the dial, while a similar record is made upon a second dial placed upon the same arbor as the index hand. This second dial is concealed behind the face of the instrument. When the second dial has revolved once, by means of a toothed wheel, notched cylinder and click, a third dial is moved forward one division, corresponding to thirty-six records upon the first. By continuing this arrangement, the instrument is made to record upon the internal and concealed dials up to 10,000 fares.

The external hand may be moved forward or back, or held stationary, during the ringing of the bell, without interfering with the regular registration on the internal dials.

The concealed dials have their index number brought into view through an opening in the face, by opening the glass covering it, and inserting a key in an appropriate hole, and turning back the portions of the face, covering the index number. The dial is examined by the agent at the terminus of the route at the end of each half trip, and the number registered thereon noted. The index is then returned to 0. The internal dials are examined by a second agent at the end of the day, and the driver is accountable for the fares marked thereon. The dials cannot be reversed save by a key in the possession of the proprietors alone. When the index numbers of the internal dials are exposed, the bell-pull is locked, so that no further record can be made until they are again hidden.

The agent who inspects the external dial at the end of each trip, and returns its index hand to 0, can only open the glass covering the face, and cannot expose the index numbers of the second, third, and fourth dials. The agent who takes the account at the end of the day, inspects the internal dials, but cannot alter them; hence he acts as a check upon the driver and the first agent, while it is in the power of the proprietors

at any time, by a simple inspection of the internal dials, to satisfy themselves of the correctness of the records.

Should the driver neglect to ring the bell, his dishonesty is apparent to all within the coach, among whom may be a secret agent of the proprietors, and the knowledge of this fact will tend to prevent any such attempts on his part.

The novelty claimed in this instrument is, the use of a ratchet and pawl to prevent the bell being rung by the recoil of the hammer, and the arrangement of the internal concealed dials for recording up to tens of thousands of fares.

COMMITTEE ON SCIENCE AND THE ARTS.

Report on E. G. Pomeroy's Process for Coating Iron with Copper.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination, a "Process for Coating Iron with Copper," invented by Mr. E. G. Pomeroy, of Baltimore, Maryland—REPORT:

That the main features of this process, the preparatory cleansing of the iron from adhering oxide, and subsequent dipping in a bath of the melted covering metal, resemble those already in common use for tinning and zincing iron. The novelty consists in the mode by which the surface of the iron is preserved in a perfectly clean metallic state at the high heat to which it has to be subjected, before it can be dipped in the melted copper. This is effected in the following manner. After the iron has been cleansed by rubbing and pickling, it is dipped for a moment in diluted sulphuric acid, then withdrawn, and the adhering acid quickly dried up on the surface of the plate by holding it over a hot fire. The iron thus covered with a thin adherent coat of sulphate is then again dipped in a thick slip of rather fusible clay, which is dried up as before by exposure to the fire. The plates thus coated are placed in a suitable furnace, and raised to a heat considerably above the melting point of copper; in this state they are dipped, one at a time, in a bath of copper kept in a state of fusion in a reverberatory furnace. The clay coating of the plate, rendered still more fusible by the silicate and sulphuret of iron formed at the heat employed, separates as a fluid slag on the surface of the bath, as the iron plunges beneath it, and the iron is withdrawn covered with a uniform coating of melted copper.

The copper plates shown the Committee had all been subsequently passed through the rolling mill to give them a smooth and polished surface. When annealed, these plates seemed to possess all the qualities which could have been expected. The toughness of both iron and copper was unimpaired; at the same time their adhesion to each other was such that no amount of working and bending at sharp angle as in a lap joint seemed to occasion any separation.

A plate with its exposed iron edges previously protected by wax, was immersed in diluted sulphuric acid (5 water to 1 acid) for a week, without any disengagement of hydrogen, showing the copper coating to be continuous.

The Committee regret that some iron spikes coated at their request by this process, which from their irregular shapes could not be rolled after they had been dipped, did not seem to be so completely protected, as the iron was rapidly dissolved, the gas escaping through numerous minute pores in the copper surface; whether this porosity was only accidental in this case from the rougher surface of the spikes preventing a perfect cleaning, or whether it is the natural state of the coating in its unrolled condition, the specimens supplied the Committee have been insufficient to determine. If subsequent rolling is essential to close the pores of the copper surface, it will shut out many useful applications of the process to articles of irregular form.

The Committee consider that Mr. Pomeroy has attained a gratifying success in a very difficult object; the materials employed in his process are cheap and abundant, and the manipulation simple. The Committee think that the coppered sheet iron will be a new and valuable addition to the materials used in the arts, and would specially call attention to its applicability to roofing, rain pipes, and other uses in which iron is exposed to atmospheric agents. At the cut edges of the sheets, oxidation of the iron would at first sight seem likely to occur with increased rapidity from galvanic action, but as the oxide of iron thus formed is retained in place by the films of copper on either side, the Committee consider that in practice this corrosion will be found unimportant in extent.

By order of the Committee,

WM. HAMILTON, *Actuary.*

Philadelphia, Feb. 10th, 1853.

Report on Junius Judson's Governor Valve.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination, a "Governor Valve," invented by Mr. Junius Judson, of Utica, New York—REPORT:

That this invention is intended to improve the system of governing or regulating the admission of steam at the throttle valve of a steam engine, and consists, 1st, of a modification in the form of valve used; and, 2nd, of a means of balancing the pressure of steam upon it, rendered necessary by the small amount of power developed by the governor; this alteration being rendered necessary by the adoption of the preceding. The usual form of valve used for governing, is pivotted at or near the middle of its area, and has beveled edges, so as to make a joint tolerably tight when closed. But that valve, from its construction, possesses the defect of opening unequal areas with equal radial movement at different positions, so that after an increase of speed of the engine has raised the balls to full height and closed the valve, they are required to fall considerably before the valve opens an area large enough to admit the usual quantity of steam to the cylinder. By this time the engine will have slackened its speed, when the impetus given it by the fresh inlet of steam again throws up the balls, so that a kind of oscillation in the valve is kept up, which is not favorable to uniform velocity of the engine.

The invention in question is an attempt to overcome this difficulty

in the following manner: The valve itself is a disc with two opposite quadrants (or nearly such) removed; it is, therefore, of the description usually known as "fan valve." Its face is ground flat with the face of a valve seat, on which it revolves, and through which two openings are made of a shape such that successive areas of these openings are uncovered by the valve in its motion, proportioned to the requirements of the engine. In other words, the valve is opened more rapidly at first, and with a movement more uniform than the butterfly valve.

In combination with this valve there is a regulating screw pressing against the face, which by being screwed in or withdrawn, relieves the valve from the friction incident to the steam pressure on its back, and so renders it easy to move it by the power of the governor balls, while at the same time the leakage is not materially increased.

It is furthermore the design of the inventor to alter the arrangement of the governor itself, as usually made, so that the arms when at rest occupy a position nearer to horizontal; this is done in order to make the angular motion more nearly proportional to the vertical heights to which the balls are raised by the motion of the engine, (or which is the same,) to equalize the motion of the valve on its seat.

The defect previously pointed out is one which is known by engineers to be incident to the old arrangement for governing; and to produce so much irregularity of motion that it cannot be employed without modification for some branches of manufacture which require a very uniform speed, as for instance in the cotton manufacture. It is the opinion of the Committee, both from an examination into the principle on which Mr. Judson's improvement is based, and from observation of its application to some engines in this vicinity to which they have had access, that it promises decided advantages over the ordinary arrangement, and deserves to be generally introduced.

By order of the Committee,

WM. HAMILTON, *Actuary.*

Philadelphia, Feb. 10th, 1853.

BIBLIOGRAPHICAL NOTICE.

A Treatise on Hydraulics for the use of Engineers. By J. F. D'AUBUISSON DE VOISINS. *Translated from the French, and adapted to the English Units of Measure. By* JOSEPH BENNET, *Civil Engineer.* Boston: Little, Brown & Co., 1852. 8vo. pp. 532, and 5 plates.

There is no subject within the range of applied science which presents more practical interest to our country than that of hydraulics. Our immense and extensively distributed water power, the sparseness of our settlements, and the high rate of interest consequent upon the great demand for capital, render hydraulic power the great resource of far the largest part of our country. Hence, the very great number of patents for water wheels and other hydraulic machinery, which grace the records of our patent office. But the greater brilliancy and attractiveness of steam power, the demand for it in the vicinity of our large cities and other places, where the population is more dense, and circumstances tend to make it the